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TASTE, TEACHING AND THE UTAH TEAPOT:

creative, gender, aesthetic and pedagogical issues surrounding the use of
electronic media in art and design education,
with particular reference to hypertext applications

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SUMMARY

This investigation charts a number of complementary explorations at the site of electronic media in art practice and design and media education. Artists are increasingly using video and computer technology in the production of their work, and these shifts are reflected in the way design and media courses are taught in Higher Education. This study seeks to relate a number of often contentious issues, but complex questions are central to any debate about the use of electronic imaging technologies by artists and the implications for teaching and learning. In this respect, the thesis is informed by my dual role as an artist using electronic media and as a lecturer in video and digital imaging in the Media Department at the University of Westminster.

The study is based on a particular model of action research, and seeks after the manner of Glaser and Strauss (1967) to “ground” theory in the aggregate perceptions, understandings, and artistic or pedagogical orientations of those seeking to bring order to their own experiences in the settings.

The text is arranged in eleven chapters. It begins by introducing the boundaries of the phenomena under study (which is necessarily ragged and untidy and challengingly gritty, since the composite issues have yet to have attracted any clarity of exposition, and the field is in any case characterised by imaginative leaps and cross-fertilisation) and the methodological and idealogical stances adopted. Methodologically the thesis is wide-ranging and eclectic, although also contained within the kind of feminist epistemology proposed by Sandra Harding (1992), Marnier Lazreg (1994) and others. It then moves on to examine a number of focal points and issues related to the use to which electronic media is put by

artists. These topics include my own sustained attempts to develop non-linear computer systems for mapping associative thoughts, and a more general and more detailed study of the principles and characteristics of these systems when they are used for holding information about knowledge domains. Following this, there is a chapter dedicated to the application of these principles to a particular knowledge domain, colour theory, with the aim of designing a computer aided learning package. The interconnections between all the topics, issues and themes studied in the text are highlighted in the middle of the thesis before moving on to more specific investigation of the issue of gender in both technological education and creativity, with an emphasis on the use of imaging technologies by women artists. The impact of these technologies in terms of shifting aesthetic values and tastes forms the basis of the final chapter, and a conclusion seeks to offer both a tentative intellectual synopsis and to indicate how the exercise has influenced and affected my work as an artist.

I am aware that to some extent this arrangement challenges both the linear quality of conventional research reportage and academic distrust of promiscuously interpenetrating ideas. I trust that this form of discourse, deliberately chosen, is experienced as working within its own terms.

TABLE OF ABBREVIATIONS

CAL	Computer Aided Learning
CML	Computer Managed Learning
COMM	Communications
DTP	Desk Top Publishing
GAMMA	Girls And Mathematics Association
GIST	Girls Into Science and Technology
HCP	Humanities Curriculum Project
ICA	Institute of Contemporary Art (London)
IRS	Information Resource Services
JANET	Joint Academic Network
LED	Light Emitting Diode
MIT	Massachusetts Institute of Technology
MOMA	Museum Of Modern Art (Oxford)
NASA	North American Space Agency
PC	Personal Computer
RAM	Random Access Memory
ROM	Read Only Memory
RPM	Realities Per Minute (Timothy Leary)
SIMM	Single In-line Memory Module
VDU	Video Display Unit
VR	Virtual Reality

GENERAL INTRODUCTION

The research project reported here cannot be distinguished from my working life. The common thread of personal involvement in the matters under review would seem to justify regarding the endeavour as a form of action research, which has not only developed and extended my critical view of the work that I am involved in, both as a teacher and an artist working with electronic and digital technology, but has also turned participation into a quest for understanding. In this sense, then, the thesis is opportunistic research that began as a need to respond to some of the puzzles, tensions and ambiguities that I have experienced both in my professional work as a lecturer in Further and Higher Education, and in my work as an artist. Other issues crowd in on the same site, demanding concurrent attention. For example, the use of electronic media in art education raises some interesting curriculum development issues which are not easily separated from relevant traditional and emerging aesthetic traditions in art and design, traditions which themselves seem to be undergoing a radical shift as a result of the impact of new technology in the arts. Gender issues are held to play an important part in any attempt to make sense of the relationship between new technology, art practice and education embedded as they are in the ideological assumptions brought to the interface.

Alongside tutoring in media practice at the University of Westminster, I have sustained a parallel creative role as a video artist working with computer imaging technology, a practice which has put me in contact with discourses differing from those I encounter in my capacity as a lecturer. At one level such seriously pursued artistic endeavours feed my teaching, even though some of the connections that they prompt me to make are not readily resolved within education (for example the connections that I have made between computer imaging and psychedelic drugs). My present post gives me access to a youth subculture that seems

increasingly to be located at a place of collision and overlap between high technology and low culture, where “computer nerds” often go “cyber punk”.

The interwoven problems which make up these aggregate puzzles have interested me enough to prompt a systematic enquiry. The most basic insight is that the issues I am seeking to illuminate substantially overlap, and in recognition of this, the approach undertaken here treats them like a family, to be resolved alongside each other. To explore the site where these problems converge I have chosen a method which is in part philosophical, adopting a “feminist epistemology”, in part a cultural analysis, in part seeking to deploy forms of analysis that go beyond “privileging the subjectivity of the oppressed”. It is also important to treat the whole as a case study, although the “case” is necessarily “bounded” rather loosely. My own observations and interviews with both “experts” and peers have been used to triangulate with other sources of information. Designing the computer-aided learning program for colour theory teaching, which, was undertaken with its research potential in mind, also proved to be a sustained piece of research indirectly exploring implicit accounts of the epistemology of knowledge domains as they inform the “academic” world of the college.

In seeking to make sense of this aggregate bunch of puzzles, I have sought to deploy various theoretical frameworks in the eclectic cross-fertilising manner that the subject matter appears to require. Particular use has been made of aesthetic theory, discourse theory, classroom and workshop ethnography and feminist cultural theory. The insights are not pressed towards the kind of exhaustive investigation that allegiance to a single theoretical framework would offer, precisely because they are being deployed selectively in parallel. None the less, each is regarded as important. In particular, discourse theory is an important

general framework for the research; computer discourse, aesthetic discourse and gender discourse are enmeshed to such an extent that one of my puzzles has been whether we are dealing with a new discourse which has arisen out of this bulb of conflicting and yet interconnected discourses. I have been influenced to some extent by Clifford Geertz's (1983) endorsement of sociological imagination in seeking to understand matrices demarcated by overlapping sub-cultures, each of which might require an ethnography of "thick description". Geertz is equally supportive concerning the possibility of interwoven discourses, which he calls "blurred genres", noting how a

"jumbling of varieties of discourse has grown to the point where it is becoming difficult either to label authors ...or to classify works."

Geertz (1983) p.20

This blurring of genres, dramatically confirmed in my own research, can perhaps be regarded as characteristic of the post-modernist culture. In fashion there has been a strong movement away from an easily defined "look" and a sweep towards the amalgamation of many styles and looks. The wearing of functional sports clothing has become obligatory to the Thirty-Something character who was a Beatnik in the Sixties; it has been adopted by black rap artists and their supporters and is worn to Raves (the contemporary warehouse party) by a broad cross-section of British youth. The mixing and merging of fashions, literary themes, artistic techniques and architectural styles has become the style of the Nineties. In video artworks there is a similar amalgamation, in April 1992 at The World Wide Video Festival in Den Haag, Holland, the graphic style of video games could be seen in an installation by British artist George Snow. In this piece computer images of space craft sped above articulated lorries down highly coloured highways projected on to screens that surrounded the viewer. The colours and

themes were reminiscent of Rave graphics, or the films projected at gigs by bands like Cabaret Voltaire. Snow's soundtrack was by Art of Noise, remixed by 8-0-8 State. Video artists have always had associations with popular music and Snow's installation was an extravagant example of this collaboration.

Presenting art as a cultural system demands an anthropological or ethnographic framework. I have already suggested how the work of Clifford Geertz offers a path into this area, with Geertz becoming a kind of talisman for "local knowledge" in particular settings. His theory of blurred genres also acquires special resonance in this study of an interconnected cluster of problems. According to Geertz, "the innovative is, by definition, hard to categorise", although the possibilities of realignment need to be radical:

"What we are seeing is not just another redrawing of the cultural map ...but an alteration of the principles of mapping"

Geertz (1983) p.20

In this thesis considerations of technical innovation, curriculum innovation, innovative aesthetic theory and gender role reappraisal all combine in a way which not only blurs their individual genres and mixes their separate discourses, making it no longer satisfactorily possible to map them as isolated intellectual traditions, even allowing them shared borders of contact and connection. New principles of mapping are needed, which celebrate rather than marginalise the points of connection, unconcerned even by their possible transient nature.

Another necessary framework for the present thesis is aesthetic theory, both its "legacy" and its potential for reconstruction. The work of Beardsley (1966) has been particularly seminal here, although his general history of aesthetics needs to

be fleshed out with two recent focal concerns, feminist aesthetics and the still evolving aesthetics of art in the machine age. There is also the question of how the art of technology interfaces with the technology of art.

The eleven chapters of the thesis correspond to substantive areas of investigation, with a concluding section which brings them together without seeking to collapse them into a single discourse. When faced with so many converging issues and interrelated theoretical frameworks, and given my interest in hypertext systems, I have found it difficult to present the research in a narrowly linear form which I believe would have precluded the kind of networking which allows the proper depiction of clear multiple interconnections. My affection for hypertext largely stems from its flexibility in presenting information, in particular the way that it facilitates connecting bodies of text in a non-linear way to produce networks of data.

Another useful way of representing the concerns of this thesis is to regard it as having four distinct substantive foci, which to some extent serve to “cluster” the chapters, but also in part cuts across them.

Substantive focus 1: a background to computer technology in art education

To look at computer technology in relation to art courses and art practice in Further and Higher Education is to invite engagement with a number of focal issues. The present account has at its heart the socio-cultural study of computer technology in education. Technology in art education needs to be viewed against an awareness of technology in its larger context. Part of this background is the general history of technological developments in relation to art courses,

considering the effects of, and responses to, other technological innovations which have historically become part of art practice; innovations like photography, and the mechanisation of the processes of art production both of which generated the capacity to produce multiple and reproducible images.

At a more general level, the information technology revolution has radically changed our concepts of communication and information exchange, with the barrier that physical distance once maintained in communication minimised by electronic and digital equipment. The sensation of being in “a global village” (McLuhan 1982) has lowered some of the barriers to international collaboration between artists and educators. For example, students from Gwent Art School have been producing art works between different European cities across the electronic mail networks for some years and in the Autumn of 1993 the Fourth International Symposium of Electronic Arts (FISEA) at Minneapolis had panels and courses broadcast around the world on satellite, with artworks transmitted over the satellite system.

The ideological roots of many of the technologies having parallel applications in classrooms is not without attendant irony. Certainly the computer in the classroom underacknowledges its historical legacy from military technology, and it is possible to argue that this latent “training” connection has greatly affected the functions and applications of the computer technology that we use in education, amounting (in the eyes of some analysts) to a suppressed legitimacy crisis. This crisis is noticeably acute for women, particularly in relation to widespread feminist distaste for the legitimisation of aggression in patriarchal culture (see Janice Moulton 1992). The association of video and computer technology with military research and development has also had a powerful influence on the

relationship between artists and new technology, particularly where there are echoes reflecting dominant military applications (although in passing it would be fair to admit benign uses of the resulting VR simulators for commercial flying and even car driving). Nevertheless, it is a great cultural paradox that quasi-military technologies and scenarios are currently being employed for apparently incompatible uses like video arcade entertainment, but the commercialisation of them has resulted in artists gaining unprecedented access to Virtual Reality (VR) systems. In 1993 at the annual international computer graphics showcase, SIGGRAPH, a number of artists used VR technology to produce artworks (see Fig. 1).

New technologies often prompt, if not actually promote, “future shock”. This frisson of self-induced alarm is currently evident in the responses people are having to the notion of VR systems, ranging from ecstasy to paranoia, with individuals typically vacillating between the two extremes. These VR set ups allow remote communication between people via computer networks that simulate a three-dimensional computer space, a kind of computer-generated meeting place. At this level, VR offers a digital escape from reality to virtual realities that might become addictive. Simulated realities which rely on a close and sensitive connection (almost a fusion) between human and machine have a whole variety of current and potential applications. There are no simple answers to the ethical questions that such mergers raise, and in addressing them there are many assumptions to confront, often to do with our egocentric perception of the human being as that-which-is-most-evolutionary-advanced. There are also our “techno-fears” to face. Our collective memory of genetic experiments in Nazi concentration camps are reawakened by new genetic discoveries and the possibilities of Frankensteinian sagas are constantly being invoked by an excited

Press. The Frankenstein fear readily focuses on our concerns over the potential for human-machine mergers. Mary Shelley's Frankenstein saw the monster built from the raw material available in charnel houses. Today the raw material is in a less literal sense digital.

Until very recently human beings have held on to the notion of consciousness as supremely characterising our distinctive attribute contrasting with machines. Yet the functions which we have traditionally relied upon to signify our humanness have been imitated by machines, to the point that our identities are showing signs of becoming blurred with those of the machine. Even consciousness is now in the sights of the AI creators, and in some areas, for example chess, machine intelligence is within range of passing the Turing Test (see George Atkinson, Chess and Machine Intelligence 1994). Describing the workings of the mind mechanistically and augmenting mental functions with machines, together with physically augmenting the human body with pace-makers, plastic hip joints, spectacles and hearing aids, have all continued the erosion of the divide between the two. Popular culture is filled with expressions of our fear for the future, the fear of machines which might become indistinguishable from humans. This is a future where androids and cyborgs culminate the blurring of machine with human. Science fiction writing and film making have both been form for expressing our future shock and our fear of being consumed by technologies which might be developed to a point where they become self-acting, outside of our control.

To map the effects of technology on art practice necessitates the mapping of the connections between genres that have become merged with technology and art. The chapters *Designing a Computer Aided Learning Package* and *Technology*

Led Curriculum Development in Art Education both address the issues of the first substantive focus.

Substantive focus 2: computer aided learning and the evolution of hypertext as a curriculum resource

The development of hypertext and hypermedia as curriculum tools is another issue that continues to inform the technology in education debate. My own analysis of hypertext as a tool uses three examples, which were chosen because they facilitate a study of issues such as the problems of mapping knowledge domains on to the computer and the fusing of different texts.

I introduce these questions through an excursion into personal biography. The chapter *From Sequitur to Nomad Zone: an Exploration of Two Principles of Mapping* is in part a retrospective reflection, cast in the context of this investigation, on my MA thesis, *Sequitur*, which took as its subject the substantive and iconic exploration of personal associative links which made up a section of one of my thought webs. The thought web I chose to represent mapped the influences which helped to shape an idea for a number of video sequences in preparation for an interactive video installation. *Sequitur* was in essence a paper version of a hypertext document, but instead of using electronic triggers to move non-sequentially between texts held on a computer, the reader moved between pages by flipping labelled tags manually.

The second example used in this study is a colour theory teaching package which was designed explicitly as part of the participatory “action research” element in the research. It is the subject of the chapter *Designing a Computer Aided*

Learning Package. The underlying model differs from Sequitur in that it depends not on associative links but on mapping a relatively well structured area. By the term “well structured” I am implying in its strong version the conceptual clarity of an area of knowledge like Biology. In Human Biology, for example, the systemic organisation of the human corpus lends it plausibility as a knowledge domain capable of networking concepts and facts in a manner capable of being replicated as a hypertext network. The colour teaching package design juxtaposes several structures, with some sections tidily organised, even hierarchical, set alongside other sections more dependent on labelled associative links. The overall purpose is to find a way of mapping a number of theories associated with using colour in art and design, as usually these relational networks can be seen to carry their own epistemological assumptions.

This issue is taken up from a different perspective in the chapter *The Iconography of Knowledge Domains*, which takes as its subject the different elements that make up, and considerations that contribute to, the design of CAL (computer aided learning) packages.

Substantive focus 3: the aesthetics involved in the making of images with the new technology and the aesthetics at work in the response to such images.

This focus responds to the question of whether art work made with computer technology has a particular appearance, or certain characteristics, that separate it from other art forms. Eligible data for this investigation includes the responses viewers and participants have to art made with computer technology, and aims to decipher whether there has been a shift in the visual assumptions associated with the involvement of technology in the creative process.

Creating images with the new digital technology not only crosses the traditional boundaries between art and science but often does not conform to commonly held beliefs about what either is. It is becoming increasingly difficult to categorise image makers or classify their works. What, it might be asked, is Myron Krueger - artist, computer scientist, or writer? What is Margeret Benyon - physicist, artist, or inventor? What is Sinclair Stammers' video Optical Experiments - the record of a chemical experiment, a work of art, or a New Age music video? What is Krueger's Metaplay - an environment for the study of human behaviour, an art work, or a vehicle for testing technological set ups? Are Mandelbrot's fractal images pleasing artworks, archetypal images, psychedelic icons dependent on non-natural colour control, or simply a visual representation of $z \rightarrow z^*z+c$? We are in the process of re-evaluating what constitutes art and what science, permitting them to be no longer mutually exclusive.

The collision between art and science, as between the feminist aesthetic and notions of creativity, are highlighted as part of a study of women's video art work and my experiences of working with video and computer technology within art practice. In considering a feminist aesthetics, I have tried to gauge the extent to which there is a counter culture amongst feminist video directors, in particular looking at the use of the female body and female eroticism in video art. When working in the arena of the female and the erotic, certain types of settings seem to offer a sense of protection to the women involved in the production of these works; these settings are not simply physical, they include the attitude of the crew towards the female body and the dynamic of the technical team. There are in the wider culture some rule-bound gendered settings, such as the male artist working with the female life model, where as long as the rules are not broken a sense of

relative ease can be achieved. Who makes the rules up and what happens when these rules are broken was one of my concerns when writing my BA thesis in 1987. Since then the full complexity of the debates surrounding images of female eroticism has begun to emerge, and the position that I held then as a radical feminist opposed to the study of the naked female form by men has changed; though by how much I am still not sure. The male gaze still makes me uneasy and I still suspect that gaze of being a kind of devouring. I continue to have a protective feeling towards women's work about female eroticism, and wonder if men view these works with eyes that are used to seeing pornography made by men, and sometimes feel that we should be keeping this for ourselves to contemplate. I should perhaps state explicitly at this point that this section of the thesis shares one of the established concerns of feminist research, to use women's subjective experience as a legitimate basis for establishing interpretive social truth (see Lazreg (1994) and Sherwin (1992)). This stance is no longer treated by the patriarchal academic establishment as less legitimate than any other "ideological" research, eg the neoMarxist critique of schooling. The chapter devoted to these issues is *Electronic Media at the Cultural Crossroads*.

Substantive focus 4: gender

Gender is centralised further in substantive focus 4, where the emphasis is on the marginalisation of women both within sites linking new aesthetics and technology and in technological environments generally. It seems particularly relevant here to include some consideration of general cultural mores, including prevalent current myths of maleness and femaleness. In this mythology, "maleness" is perceived as rational, linear and serial and associated with order and control, in contrast to "femaleness" which is irrational, non-linear and disordered, although on a more positive note sometimes perceived as holistic and concerned with connectivity

and intuition. Within these framing assumptions, computer technology has long been associated with the masculine, utterly logical and linear. When it comes to women artists working with this kind of technology there are two opposing myths on a collision course; the equivocal “femaleness” of the creative process (for a subtle reworking of this gendered theory of creativity see Christine Battersby Gender and Genius: Towards a Feminist Aesthetic, 1989), particularly in a woman artist, collides with the perceived “masculinity” of new technology.

Interviewing and reading about women who work at the site of this collision reveals some common experiences and concerns, and from case studies and cameo interviews with artists, students and lecturers, certain points have become highlighted. Firstly, there are similarities in the women’s experience; of problems in getting access to equipment, of the male jargon and of the aura surrounding the technology which many women find alienating. If these initial hurdles can be overcome, then attempts to integrate techniques and technological equipment into an established work practice reveals more shared concerns.

The chapters *Gender and Technology*, and *Women Artists and Video Production as Action Research*, both deal with gender-related issues.

THE METHODOLOGICAL MATRIX

There is a sense in which any thesis hinges on its methodological justification, and this work is not only no exception but carries further complex issues to do with its structure which is seen as a decent compromise between the linear discourse of conventional research and the more promiscuous spirit of hypertext, visual imagery and creative endeavour which are close to the heart of its subject matter. In Richard Jaeger's AERA textbook (1988) on complementary methodologies in Education, Lee Shulman argues convincingly that "the choice of method of inquiry involves more than determination of the way in which a given research question will be answered. To a great degree it also determines the nature of the research question that will be asked". In particular, ethnographic or naturalistic inquiry methods tend to open up a much wider range of questions.

This research uncompromisingly deploys an eclectic methodology, seeking to combine a variety of approaches. Thus there is no single methodological paradigm, but relevant research traditions are used as appropriate. There is a kind of intersection between this eclectic methodology and the resulting insights organised with some interest in non-linear forms of discourse. Accordingly, this research has become, like historiography and much qualitative educational research what Shulman (1988) described as " ...a methodological home for a wide variety of approaches, techniques and modes of inquiry, ...a methodological mosaic".

The educational research traditions that inform this thesis can be seen as falling into a number of clusters. Centred on naturalistic fieldwork in a real world non-experimental setting, it relies to a large extent on standard ethnographic approaches including observation, semi-structured interviews and product analysis. These offer the starting point of our account.

Educational ethnography and participant observation

The ethnography takes off in two directions, since the writer as a participant observer with a real role in the setting treats her situations and actions as a platform for action research, and also capable of being mapped as describable phases in her development as a video artist. As I have indicated the dominant method used in the research was participant observation. As always in participant observation, the social position of the (in this case female) observer has tended to determine what she will “see”. Nevertheless, serious attempts have been made to triangulate impressions, judgments and explanations with those held by others in the naturalistic setting of the research. But as a feminist researcher I have followed Susan Bordo (1990) in excluding the “view from nowhere” stance as well as the “Euclidean abstract position” that is held to characterise male positivistic research.

As Robert Burgess (1984) observed, participant observation can be seen as giving rise potentially to a number of different roles, distinguished by “four ideal typical field roles: the complete participant, the participant-as-observer, the observer-as-participant and the complete observer”. Clearly this research has been conducted by a natural participant who was able to become an observer, so there were no problems of the standard kind concerning entry to the setting, managing a credible role and final exit. Indeed, the participant role was sufficiently centralised in the research for it to develop some of its facets effectively into a form of action research.

Action research

In so far as the research for some of its sections touches on action research, it does so in a way broadly compatible with Nevitt Sanford's "A Model for Action Research" in Reason and Rowan (1981). Sanford characterises action research as countering the "strongly advocated separation of science from action" by focussing on the study of action as a means of developing understanding. In this model, action research can be used to further individual growth and development, in my case both as a teacher and an artist. There is a strong alternative tradition associated with the work of people like John Elliott (1987, 1991), Clem Adelman (1980), Kemmis and Carr (1986), and Grundy and Kemmis (1981). The present author uses this tradition with respect to its interest in critical theory, but departs from it in its representation of action research as likely to involve strongly collaborative research akin to the United Kingdom first generation curriculum project. In part this tradition arose from the historical roots of British and Australian action research, which developed at the Centre for Applied Research in Education at the University of East Anglia under the influence of Lawrence Stenhouse and the Humanities Curriculum Project, in relation to which Stenhouse pioneered the notion of the "teacher as researcher" able to take a detached and curious view of his or her own performance (see Stenhouse 1975). One dilemma that I have sought to resolve in using both action research and "feminist standpoint theory" (see Lennon and Whitford 1994) is that the former tends to value the kind of "non-partisan curiosity" approved of by Wolcott (1988) who urged the ethnographic researcher to be detached as well as involved, and the latter which is ever seeking to "politicise the personal" and empower women in potentially action-rich contexts. My attempt at a practical resolution of this tension is based on my strong commitment to intellectual understanding and the

view that even extremes of ideological attachment and scholarly detachment can be held in common. The feminist agenda falls within the assertion of Carr and Kemmis (1986):

“The problems of education are ...problems of acting educationally in social situations which typically involve competing values and complex interactions between people who are acting on different understandings of their common situation and on the basis of different values about how the interactions should be conducted.”

Carr and Kemmis (1986) p.180

General hermeneutic theory

The third cluster of methods involves drawing inspiration from general hermeneutic theory (see Richard Palmer's Hermeneutics: Interpretation Theory in Schleiermacher, Dilthey, Heidegger, and Gadamer, 1969), particularly as applied by Dilthey (1990) and Kinneavy (1983) (see also Eagleton 1983). This use of the method involves treating events and their attributed meanings as if they were texts. This is especially appropriate in the light of the assault that written texts have come under from electronic media technologies. Computing equipment, in particular hypertext systems, have disrupted the text's linearity, seriality and its authorial voice. The problem originally addressed by hermeneutics was one of how, in a culture that values sacred texts, one argument or interpretation can be presented, pressed or preferred over another. The science of interpretation that developed as a response to this problem, and which placed the so-called “hermeneutics circle” at its centre, has provided me with a way of seeking to understand complex cultural matters by cross-referencing between the part and the whole.

The way in which we interpret the meaning of a body of a text depends upon our understanding of the individual words that make it up. In turn these words have a symbiotic relationship to the sentence that they inhabit and to the situation of the text. We understand the meaning of each word by seeing it in response to the whole sentence and, symbiotically, the meaning we assign to a sentence is dependent on the meaning of the individual words that make it up. This whole-part relationship, referred to as the hermeneutic circle, has what Kinneavy (1983) has called “a strong concern for the continually changing relation between whole and part, the relative notion of what is whole and what is part, the dialectic that continually functions between whole and part, and the reciprocal interdependence of each on the other”.

Faced with complex social and cultural events, I have interpreted them, within this methodological analogy, in part by treating them as if they were texts. The movement back and forth between interpretations of these events/texts is scale-dependent: the large helps to interpret the small and vice versa. If it is accepted that events can be analogous to texts then they can be interpreted like sentences and understood as having contextual rather than autonomous meaning. In hermeneutic theory, the autonomy of text is far from being the rule. Kinneavy cites the doctrine of *kairos* as being in classic opposition to this autonomy. *Kairos* is difficult to translate but its meaning encompasses fitness, proportion, due measure, the critical time or occurrence, the right time, the state of affairs. *Kairos* contributes to the “situational context”, which is important to the composing and interpreting process. The situational context is made up of *kairos*, *topoi*, *prepon* and *hypothesis*. The notion of situational context, and *kairos* are important. In cultures, too, ideas and insights tend to have their own *kairos*, and new interpretations are particularly important at times of cultural shift of the kind

addressed in this thesis. We are dealing unavoidably in “situated cognitions”.

As previously indicated, one major inspiration in my work has been the writings of the cultural anthropologist Clifford Geertz (see for example Geertz 1983).

Although warning how unfocussed the term “text” can be when it is applied to social action and the behaviour between people, Geertz in general allows the text analogy, although seeing contemporary culture as characterised by the equivalent of intertextuality, and the intellectual life increasingly an engagement with blurred genres. Inscription, the fixing of speech into text, takes away the transience of speech and gives the meaning of speech (or action) some resonance.

Geertz proposes that the properties which connect “texts” are coming to be seen as important as those which divide them. Various connections and reverberations have joined together the different parts of my reflections around electronic media as a woman, student, artist and lecturer, and the thematic resonances are an important part of the justification in blurring the genres. Although my pivotal themes may appear superficially unrelated; subtle linkages are ever present, even criss-cross between the use of electronic media in art and its historical and cultural associations with the military; popular culture in the form of science fiction. The thesis pulls in other concerns: the stereotyping of women as incompatible with technology; the aesthetics of computer scientists and artists. All these have contributed to the construction of the “text” of electronic media, their semiotic connections forming an “almost continuous field ...[of texts, which] ...we can order only practically, relationally, and as our purposes prompt us” (Geertz, 1983, p.20). Throughout this thesis I have attempted a relational ordering of the “continuous field” of “texts”. Once again, I am using “text”, and “textual analysis” not just to mean the written word, but to include appraisal of images,

artifacts, socially attributed meanings and events.

Cultural anthropology

Other approaches are important when dealing with cultural meanings and situated cognition. Geertz's writings on local knowledge, particularly the book by that title (1983), can be seen in parallel to his notion of blurred genres. His standpoint is that art, amongst many other things, reveals and displays the feeling that a people have for life. Geertz lists religion, morality, science, commerce, technology, politics, amusements and law as the forms of life that art is placed against, arenas from which it gets its context. He takes this contextualisation further by saying that as an art object gets its cultural significance from its position in a pattern of life, and that its cultural significance is a "local" matter, although capable of being "found" as well as "lost in translation". I have chosen to look at the case of art produced with electronic media with these ideas in mind. The initial ostracism of electronic art by the art community may be associated with the lack of assimilation of computers in everyday life in the nineteen sixties. By the nineteen nineties in the "developed" world all that has changed, and all the areas that Geertz named as making up art's context began to utilise computer technology. To talk about art, especially that which is produced using electronic media, depends on it being assimilated, and placed against, these other areas of life. The use of electronic technology is now a part of our "period eye" (Baxandall, 1972). When talking of the period eye, I refer to the skills of interpretation brought by the viewer when s/he looks at complex visual simulations. The experience of living in the age of information technology has equipped many of us with an eye that is skilled in interaction with computers, can "read" the pseudo three-dimensional space of computer simulations and which is currently in the process of developing

skills for navigating virtual worlds.

Feminist standpoint theory

The research is substantially informed by, but not strictly limited to, recent feminist notions on the nature of the research enterprise. It is important to indicate what is involved in taking the particular feminist ideological stance that I have chosen from the slightly confusing complexity of what is on offer. At heart, my stance involves a willingness to engage in privileging the analysis of life as experienced by women as a particular oppressed group. This prioritising of what Kimberly Hutchins in Lennon and Whitford (1994) described as “the subjectivity of the oppressed” is premised on the belief that accounts of social life have been dominated by implicit male epistemologies. This thesis uses “feminist empiricism” and “feminist standpoint theory” (see Harding in Lennon and Whitford 1994) as a strategy for reshaping social inquiry in order to restore the full human voice. There are however some well-understood difficulties, and I have sought to avoid the kind of “essentialist thinking” which Marnier Lazreg (1994) warned of, which by treating women as a kind of alternative universal category might simply end up seeking to impose non-situated metanarratives of its own. With regard to metanarratives, this thesis finds itself uneasily poised between sympathy for Lyotard’s postmodernism (1984) with its view that “the postmodern condition has rendered these grand narratives obsolete” and the not altogether compatible view that feminism is claiming for women the traditional Enlightenment virtues of intellectual and emotional reasonableness, virtues which we are reluctant to yield up to the fragmentation of postmodernism whilst they are yet barely won. As Nancy Hartsock (1990) puts it:

“poststructuralist theories such as those put forward by Michel Foucault fail to provide a theory of power for

women ...In its place [women] propose a social criticism that is ad hoc, contextual, plural, and limited.”

This is perhaps no more than a feminist version of what Dilthey (1969) intended in his foundational assertion that “life itself should be that out of which we must develop our thinking and toward which we direct our questioning”.

The main substantive focus is an attempt to deconstruct politically what is going on in settings where women come into contact with new technology. At these points the thesis aspires to be historically-rooted cultural criticism, based on ethnographic studies. I have attempted to resolve the dilemma of much ethnographic fieldwork, the tension of trying to achieve an equilibrium of detachment and involvement, through the triangulation of information obtained in many ways and from multiple sources (see Wolcott, 1988).

One project requiring attention from the stance of “feminist standpoint theory” is the so-called “hidden curriculum” of Higher Education in so far as it structures gendered perceptions of social life, turning these into universal cultural norms. The view taken of these matters borrows from Gramsci (1975), whose account of hegemonic oppression suggests that the myths of dominant groups (in this case based on gender rather than class) actually infiltrate the common sense of those sharing what Yeatman (1994) has called “subaltern consciousness”, leading to a situation in which the oppressed wear their chains willingly, controlled by consensus rather than coercion. This, of course, is exactly the kind of false consciousness that the feminist movement is seeking to address, and one of its analytical tools for doing so is the deconstruction of sexist language in the workplace. This is particularly important in a thesis treating women in high-tech environments, and my attempt to investigate the language through which women

are alienated is a project that is based on ample precedent and is methodologically secure, and not just in the feminist literature.

Aesthetic criticism

One facet of the thesis asks questions about whether emerging or novel cannons of taste need to be asserted in order to explain the cultural role of electronic imaging and the criteria by which it is held to be pleasing or otherwise. The discussion of the new aesthetic associated with computer generated imagery is to some extent grounded in contemporary cultural history, seen through the lens of a history of aesthetics as generating issues that need to be addressed today. The rest of it is almost akin to literary criticism as I treat events that surround the production of new images as just as open to the same kind of deconstructing analysis as the images themselves.

Grounded theory

Another methodological inspiration in this thesis has been “grounded theory”, the view that theory in complex field situations is not always preordinate (either as hypothesis or preferred explanation) but may be patiently built up from accumulated insights through a kind of progressive focussing. Research using grounded theory (Glaser and Strauss, 1967) is perhaps more suited to a more clearly bounded case study, but I have tried to keep faith with its basic tenet, alongside other approaches, in seeking to interpret social action, and the attribution of social meanings in a variety of settings. A parallel influence has been Dilthey. In his search for a methodological bias for *Geisteswissenschaften*, Dilthey looked for a method that would be adequate for the fullness of a

phenomenon. His notion of *Geisteswissenschaften* was

“all those disciplines which interpret expressions of man’s [sic] inner life, whether the expression be gestures, historical actions, codified law, artworks or literature”

Dilthey (1969) p.98

Particularly attractive is Dilthey’s generosity concerning what is eligible as data, based on the study of a broad range of “expressions”. The social anthropology of taste demands that I engage with symbolic forms (texts, images, objects) but I also take the view that all statements about events pertaining to the area being studied are legitimate data. These statements include existing research, articles in journals, interviews, conferences attended, conversations overheard and past experiences.

The methodological matrix

These methodological approaches have formed the “matrix” which I have used to interrogate and transform my experiences as a woman artist and lecturer working with electronic media. To press an electronic metaphor, it is as if this matrix could be imagined as a network of “circuits” which has been used to combine several “signals”. “Circuit” seems an appropriate signifier to use to describe each of the methodological approaches taken in the research process; each one of these styles of enquiry and concomitant interpretation, whether of behaviour, image, trend, or cultural nuance is a “complete communication channel” (Chambers Science and Technology Dictionary, 1991, p.162). At the same time each circuit embodies a contributory and complementary interpretation of that world; it amplifies, oscillates or controls the flow of the signals. For the purpose of this research, I have used “signal” to describe that which conveys information (Chambers

Science and Technology Dictionary, 1991, p.813) but have broadened its connotations beyond the purely technical. I have treated a range of personal experiences, from attendance at conferences and overheard conversations to interviews and action research, as capable of conveying information (of being a signal). The aspiration of this research is to combine these circuits in such a way as to transform these different signals into an aggregate critical image of electronic media at the present time, in so far as impinges on the educational questions within my remit.

This use of the word signal to provide an appropriate metaphor for the combined eclectic structure of the discourses and complementary methodologies in the thesis, is derived from its use in imaging technology and stands in contrast to its use in semiotics.

Perhaps something also needs to be said about the stance taken in the thesis towards historical inquiry. Like all contemporary cultural analysis that seeks to exhume the embeddedness of cultural truths, there is a strong aspiration not to be ahistorical. But it would be misleading of me to claim that in any important sense the thesis is seeking to establish and vouchsafe new historical knowledge. Its main use of history is to offer some historical contextualisation of women's alienation in the technological workplace as it has developed through the way that women's experience has been mediated by certain kinds of cultural imagery. Like all history, the account offered is strongly interpretive and I have tried to respect Arthur Marwick's (1989) strictures with regard to the "pitfalls of historical inquiry".

This methodological chapter has in essence been a summarising account of the

styles of inquiry deployed in this thesis, but it will be necessary to return to methodological as well as substantive questions in further chapters.

Finally, it must be admitted that in today's postmodernist intellectual climate, methodology can no longer easily be held to offer any spurious guarantees. The road to understanding, exhuming and evaluating social meanings is an extremely complex one. All we can hope is to do is conduct our enquiries in a way that allows us to offer our interpretations with as much confidence and humility as are decently appropriate.

**FROM *SEQUITUR* TO *NOMAD ZONE*:
AN EXPLORATION OF TWO PRINCIPLES
OF MAPPING**

From scissors and tape to hypertext: structuring texts non-linearly

The experiences drawn upon by the author in attempting to unravel the complex interrelated puzzles that make up this thesis include her attempts to give structure to diverse material in two contexts, academic discourse in ordinary language and creative video production assembling and organising images and sounds. One implicit intuitive judgement lying behind this chapter is the view that the two processes have much in common, despite Marshall McLuhan's widely accepted sharp dichotomy between electronic and print environments. My attempts to work at a high professional level with both media lead me to sense considerable resonance and reverberation between them, raising issues about what is to count as intellectual and emotional order. Since my working definition of an artform is that it is seeking to use emotion to cognitive ends, both are equally concerned with arranging material for understanding. More recently hypertext as a technique and a technology has forced a reevaluation of this issue.

I produced my BA thesis in 1986 at Sheffield Hallam University (then Sheffield City Polytechnic). When I was writing Roaring Furies: Feminist Strategy in Art Education, I worked sitting on the floor of my living room surrounded by pages of my writing and relevant quotes, and used scissors and sellotape to structure them into a linear physical arrangement. This process went through many changes, and I increasingly conceived the eventual sequence as arbitrary, seeing the text as carrying an implicit non-linear structure, with the different chapters standing in parallel. I certainly wrote them that way, building them up alongside each other rather than completing one and then moving on to the next. It was difficult to find a satisfactory way of arranging the texts in what seemed to me an arbitrary serial format, since the texts seemed to function best when they were

laid out in a pattern on the floor and I could dip into one and then another. Displaying it like this enabled me to experiment with the different emphases and readings which could result from changing the order of the information.

Although “feminist standpoint theory” had not then been fully articulated, I had taken my experiences as a woman student in an art college as the basis for my thesis, focussing on cultural interpretations of a number of events which I had felt had been integral to my perceptions of the second year of the degree. These events surrounded a “direct action” taken by women students against artworks produced by other students in the Art School which they felt were pornographic. I was tempted to structure the thesis chronologically, like a diary, following the damage and theft of paintings, the subsequent violent threats by the artists, the seminars initiated by staff and students and the results of this eruption of energy on the curriculum, the students and the University. But the diary format did not seem effective, not doing justice to the entangled debates, or to the complex and often confusing collision of issues. Instead, after much work with the scissors and tape, I structured the thesis according to issues, and related events to them. although I could not have made the connection at the time I was working in the spirit of Stake’s (1977) advice to programme evaluators, and treating issues as advance organisers.

With hindsight I feel that what would have served the epistemology of the domain, best would have been to have offered a range of pathways through the text, with guides presenting the views of the different groups of people involved, including the women taking the direct action, the men who supported them, the men who were producing the “pornographic” artworks, and the women opposing direct action. Providing a range of these different “voices” through which to interpret

the same series of events would have been a complex but fruitful way of gaining an insight into the highly emotive issues surrounding pornography and the destruction of art. This would have been particularly useful given the ambiguity of the feminist voice with respect to body representation (see Andrew Ross's *The Popularity of Pornography in During* 1993), also Sontag (1982) and Dworkin (1981). Providing access to texts by disparate authors would have made it easier to place these events in a larger political and critical context, and to have drawn attention to the significance of the close geographical proximity that the Sheffield had to Leeds. In 1986 the "art, pornography and censorship" debate was raging in the North of England. Allen Jones' sculpture show was picketed by women in Leeds and the position of women students in Art education was also a hot issue; again the focus was on nearby Leeds and the controversy over alleged "sex-for-favours" compacts between female students and male lecturers. A hypertext system could have entwined all these strands of the narrative. But that was before I had come into contact with hypertext.

The non-linear and interactive aspects of my art practice and the attraction of hypertext

As an undergraduate art student I had written about "direct action" in my thesis and my artwork took the form of live performances and installation work which included interaction with the audience (see Fig. 2). The notion of dialogue between artist and audience and the energy of interaction interested me. The bringing together of audience, space and sometimes performer, to produce an event which was not fixed but shifting was part of the attraction that time-based installation work held for me.

When I came to write my MA thesis I had been introduced to hypertext and decided that this was a system which I could try to use to present my writing in a form similar to my practical artwork. Even disregarding the live performance elements in some of my work, I could sense a similarity between the experience of an installation space and the experience of a network of data presented using hypertext or hypermedia systems. In both cases, elements (whether text, photographs, drawings, moving images or sounds) can be experienced in different orders. The “audience” can take different routes around the space, see different elements at different times, just like the user of hypertext documents can explore non-linear webs of linked texts, taking different paths through them. The configuration offers parallels between the writer and the artist, and the reader and the audience/spectator. Live performance and installation seek to build bridges between the performer/artist and the spectator/participant, just as hypertext aims to close join the gap between writer and reader. Much installation artwork adheres to what Druckrey describes as

“non-linear principles of form ... [which] are the measure of a culture accustomed to fragmentation and montage. Information in this environment comes as an array rather than as a sequence.”

Druckrey (1993) p.128

Contrasting with traditional bound books, which present information as a sequence, hypertext “books” provide an array of information and mark a dialogue both between texts that the writer and “reader(s)” have linked and between reader and writer. There is typically an erosion of the distinction between reader and writer, with readers adding texts, comments and links of their own. This web-like format of hypermedia documents is what distinguishes them from linear book-bound texts. Books take as axiomatic writing’s inheritance of consecutiveness

from speech, a process in which previous articulations, discussions and interactions are made available sequentially. In this sense writing merely inscripts speech, and gives it permanence, without altering its nature. Books call for a reading which

“is not a relation of interlocution, not an instance of dialogue ...the book divides writing ...and reading into two sides, between which there is no communication ...the reader is absent from the act of writing; the writer is absent from the act of reading”

Ricoeur (1991) p.107

Although standard accounts of reader response theory try to turn the reader into a kind of second author, the basic underlying truth is as described above.

Hypermedia “webs” of text and image assault this notion of the text producing a double eclipse of reader and writer. With such webs the relationships of oral dialogue are usually not replaced, but represented by text, image and sound which is used quite literally to map the dialogue between the users. Users of electronic mail habitually replace oral dialogue with text, and have become adept at “talking” over the networks, typing rather than speaking, but leaving messages that aggregate as “live” interactions. This type of dialogue can also be incorporated into hypermedia arrays. Hypermedia does not necessarily preserve discourse in a way that keeps it a fixed archive for individual and collective memory in the same way that a text preserved in books does, but contrastingly provides a site for an expandable and shifting archive, a looser arrangement in which the archives themselves may be added to and re-structured.

The hermeneutics of interactive installations and hypertext

The circularity of the hermeneutic circle depends on its demand that we

understand the meaning of a word by seeing it in the context of the whole sentence, at the same time allowing the meaning of the sentence to depend upon the meaning of individual words. If this principle can be expanded to bodies of writing we arrive at a form of intertextuality, with the meaning of one text dependent on, and symmetrically influencing the meanings of those placed before and after it. Treating those meanings that arise from this juxtaposition, hypertext's capacity to offer a variety of different orders to a group of texts, can manipulate different positionings to prompt varying interpretations. This way of presenting texts is of particular interest to me because it has a structure similar to much contemporary time-based artwork.

Currently there is great enthusiasm by artists for interactive works which are built of numerous sequences of, for example, video or stills. The participant causes these images and sounds to be played by touching a screen in response to image or text, or activates them by walking through a space that uses sensors to trigger an audio or video player. It is the real-time choices of the audience that causes images to appear in different orders, the ordering producing a variety of narratives and thus interpretations of the same work. In this way one image/sound sequence is positioned next to another, like sentences in a text. These image/sound "sentences" can only be understood by reference to the interpretation rubrics of the familiar hermeneutic circle; "reading" the artwork depends on assigning a meaning to each segment of image/sound, but this will be contextually modified as one image/sound segment becomes seen in relation to the next and to the overall schema, which may itself be unique to each individual interaction with the piece. Each shot is like a sentence, lighting, character action, props behaving like words. Understanding the sentence/shot depends on interpreting the relationship between these words/elements that make it up. The interpretation of the shot is

subject to continual change as it is seen in response to the rest of the shots in that sequence of images. Understanding the whole piece depends on understanding the meaning of each sequence which is like a paragraph. With works that respond to the audience by displaying different arrangements of image/sound segments the meanings will be varied and people will have different understandings of the piece.

An example of this approach to producing time based art pieces can be seen in the plan for one of my works-in-progress, Nomad Zone. Nomad Zone is an interactive video installation, set in a gallery. The audience/participants enter through a narrow corridor, and as the space opens out the floor can be seen, illuminated by gradually evolving “scenes” produced by projected slide images which dissolve one into another, marking transient tracks and paths onto the floor (see Fig. 3). There are four different zones in the space, delineated by the slides: these are the Forest, the Desert, the Wetland, and the City. Where their boundaries meet there is disturbance, conflict and tension. The boundaries are not constant, but shift.

Stepping onto the floor triggers pressure pads (Fig. 4 shows the layout of the pads which are beneath a covering onto which the slide sequences are projected). Since the floor slides include images of the human body, the pressure pads are conceived as analogous to acupuncture points. Stepping on each of these pads causes a different sequence of video and sound to be played. There are thirty-six different sequences (each of the four zones is divided into nine sections). The video sequences are projected onto the curved walls that enclose the space. Each sequence is between thirty seconds and two minutes long. Similarly, the user of hypertext or hypermedia systems presses “hot” areas of a screen (either by hand

or by clicking with a mouse) and causes different elements of the data web to be accessed.

The audio-video sequences correspond to the position that has triggered them, just as in a hypertext document. The City zone is described by images which imply striation and restricted linear movement (railway tracks, traffic lights). In the Desert zone movement is freer and the images reinforce the notion of transient, nomadic presence, footprints which disappear into the sands, paths which are not fixed. As shifting sand erodes tracks in the desert, so in the Wetland the seasonal depletion and replenishment of water causes waterways and mud tracks to appear, shift and disappear.

As a participant interprets the projected video images as responses to their position in the room, and to the image on the floor that they are treading on, so they can begin to orchestrate their own deliberate sequence of images. If a minimum of four people are in the space at any one time it is possible that images from all four zones will be playing simultaneously. Self-evidently, there are numerous combinations of images that may be experienced by any individual participant, albeit some triggered by others, and as a result numerous different readings of the space.

**Sequitur: using hypertext to interpret the mapping
of a non-linear knowledge domain**

My MA thesis, Sequitur, was a textual interpretation of an idea that I was developing for some practical artwork done at that time. This video piece, also called Sequitur, was a much simplified and single tape (therefore linear) version

of the ideas from which Nomad Zone grew. The design of Nomad Zone, a non-linear presentation of images and sounds, was a response to my experience of presenting texts non-linearly.

Prior to designing the Sequitur thesis, I had worked on texts by accumulating different collections of papers, each of which might later become a chapter. When I came to write Sequitur I had recently been introduced to hypertext systems and felt them to be the most appropriate form for the production of my thesis. A non-linear method for presenting texts seemed apt as I wanted to base my written work on my video practice. This practice seemed to be non-linear at a number of different levels. On reflection, the ideas for a project took form through a process of visualising a number of objects and/or gestures. Over a period of time the relationship between these changed and they became complex and were consolidated into a number of scenes and shots (for example in the Sequitur video the action of walking was incorporated into a location shot in a field and reproduced in a studio where other images of landscapes were combined with it). The recording process is non-linear in that shots are recorded out of sequence, and though some are scripted others are an immediate response to the environment and to events as they unfold during a shoot. Lastly, the final video is always the result of numerous edited versions each one placing images and sounds in a different order.

I took the development of an idea for a video art piece (Sequitur) as the subject of my thesis and treated its somewhat random associative thought pattern as if it had the capacity to define a loose epistemological structure. I realised very quickly that I could easily be thwarted from reaching my goal of attaining some kind of correct interpretation of my thought process from the start. As I mapped my

associative thought processes I was struck by the sheer number of ideas and memories my mind had linked together in the process of forming the idea and also by the thought that associative memory itself might be elevated into an implicit epistemological model in its own right. I decided to include as many of these themes as possible at the expense of writing extensively. This decision was informed by my belief that the links between the thoughts (which I would transcribe to texts) were of critical importance. I sought to encourage diverse interpretation rather than direct the reader narrowly through the texts, facilitating diverse interpretation of the themes and possible linkages rather than simply replicating my own.

In retrospect, I can see that both options were present. By making my directions explicit, I could have centralised myself as a guide, seeking to replicate the paths by which I experienced each node of information. Against this I might have encouraged the reader to alter the texts, making their own path through the information. Enclosing blank pages or binding the thesis in such a way as to encourage reshuffling and the adding of further material would have been one way to invite annotation. Annotation would have offered scope for readers to develop their own texts and to expand the meanings derived from what I supplied.

It was a year after this that I first encountered Lawrence Stenhouse's Humanities Curriculum Project (HCP), with its lack of binding and emphasis on users adding to the material supplied, and I immediately saw it embryonically as a successful paper version of a hypertext web. The fact that HCP combined photocopied images, newspaper articles and audio recordings and encouraged teachers and children to produce their own such records is suggestive of how it might have developed had hypertext technology been widely available at the time. In addition

the HCP was a fine example of the reader-writer division being eroded. Without these two important options, annotation and the ability to add links and texts, I had retained much of the authoring control, and therefore there was no challenge to the reader-writer division. At the time I had not fully considered the position of the author in hypermedia. Since then I have come to believe that the way that hypermedia can be used to erode the distinction between the reader and the writer is as challenging and exciting as the way it can be used to create non-linear documents. In addition, of course, Sequitur was highly personal in its subject matter, idiosyncratic if not egocentric. This factor also limited the extent it could be readily detached from its author.

Although my MA was in Electronic Graphics, regulations did not allow me to submit my thesis on computer disk, and I was forced to compromise by constructing a simulated hypertext document, traditionally bound. Nevertheless I had developed each node of text using the computer much in the way a hypertext document would be developed, each node representing one of the associative thoughts which made up the web of ideas. I use the term “web of ideas” rather than “train of thought” because “train” implies something linear and sequential and this idea domain proved complexly interconnected.

The nodes included in the final draft of the thesis represented some, but not all, of those indicated on the maps which were the first item of the thesis (Fig. 5). These maps were a rough guide to my associative thought patterns and were produced from memory and by referring to notes made in sketch books. I hoped that including the maps would indicate the non-linear structure of the idea domain and show its complexity. Acetate sheets facilitated the physical mapping of the domain as it proved too complex to reduce to one readable diagram. Instead, I

used four diagrams which could be placed on top of each other as a measure of the interconnections. Viewing each one separately gave a different reading of the information, which could be viewed as a collection of writings on “nomadic pathways”, “women’s energy patterns”, “communication networks” and “evolutionary maps”. These maps can be seen as guides to the thesis.

Simulating the linking function of hypertext, which enables one node of text to be linked to many others, was more difficult. Using hypertext software it is simple to make a word or an area of the computer screen active and to ensure that clicking on this active area causes a another specific text or graphic to be displayed, but this facility is not easy to simulate. My eventual solution resulted in each page having a number of tabs which stuck out from the edges. These were labelled so the nodes were categorised by author (if they contained a quote) and by the subjects that they covered (see Fig. 6). The aim of this physical design was to encourage readers to take different routes through the body of text by flicking from one tab to another, but it had little of the versatility or speed of a computer-based system. Thus *Sequitur* did not satisfactorily resolve the problem of linking, in a non-linear way, texts which are presented in a bound form. The bound paper format immediately encourages a linear sequential reading. In addition the number of tabs (and therefore the number of links) is limited. It is just not physically possible to attach more than sixteen tabs down the side and nine across the top or bottom of an A4 page and keep the labels on the tabs legible. Even with this number of categories (thirty-four) making adequate connections throughout a larger knowledge domain would be severely restricted. In the case of *Sequitur* I got around this problem by restricting the ways that I categorised the texts and was helped by the course regulations which meant that the thesis was relatively short as it was part of my submission for a practical MA.

In conclusion, Sequitur did not succeed in practically illuminating its idea or revealing its true “spirit” in the sense proposed by Frederick Ast. Ast describes what he calls the “spirit” of a text as the full realisation of the idea that “unconsciously guided” it (Ast, 1990, p.49). The brevity of Sequitur, leaving many nodes from the network diagrams unrepresented, also obscured and damaged the spirit of the text. Another obstruction was the limited connections between the nodes that were included. Finally, and most importantly, the bound paper form precluded a freeing of the text’s spirit, disallowing the easy inclusion of elements like video sequences. The most profound effect of the loss of hypertext as a form for Sequitur was the navigation through the texts, which became awkward and restrictive to the reader.

Despite all these shortcomings, the experience of constructing Sequitur was inspiring. My brief insight into hypertext lead me to want to understand non-linear structures more fully and to explore further the computer’s role in the production of artworks. It prompted me to re-evaluate my interest in installation work with the result that I am now using non-linear pathways in my art practice in a more conscious and deliberate way, and the computer has become an important part of both my art practice and my written work.

The hypermedia *kairos*

Producing Sequitur gave me an insight into representing relationships in a complex area, and made me aware that a paper-bound format contradicted the non-linear form of the subject I had chosen. I became increasingly convinced that resolution of these matters was a question of timing, of *kairos*.

In hermeneutic theory *kairos* delineated a particular kind of appropriateness:

“The *kairos* when resolved into rhetorical skill can be defined as that which is fitting in time, place and circumstances, which means the adaptation of speech to the manifold variety of life, to the psychology of the speaker and the hearer [it has a] variegated, not absolute unity of tone.”

Gino Funaioli cited in Untersteiner (1954) p.197

Kairos can also be interpreted as propriety of time, experience, or fullness of time (Kinneavy, 1983). The *kairos* was wrong for Sequitur, but across the culture as a whole times are changing. One strong influence has been the cool dissolving of certainties and sceptical cast of mind that has gone under the label of Postmodernism. In a post-modern society where we are inundated with re-combined and montaged fragments of texts, sounds and images it seems apt to be provided with a vehicle for both producing and housing these archives and montages. The computer is such a vehicle. Especially fitting is the digital and electronic form of these computer systems as they themselves propagate the further dissemination, fragmenting and expansion of such archives over international networks. Computers also house text and image manipulation software that we can use to make more montages and include further fragments.

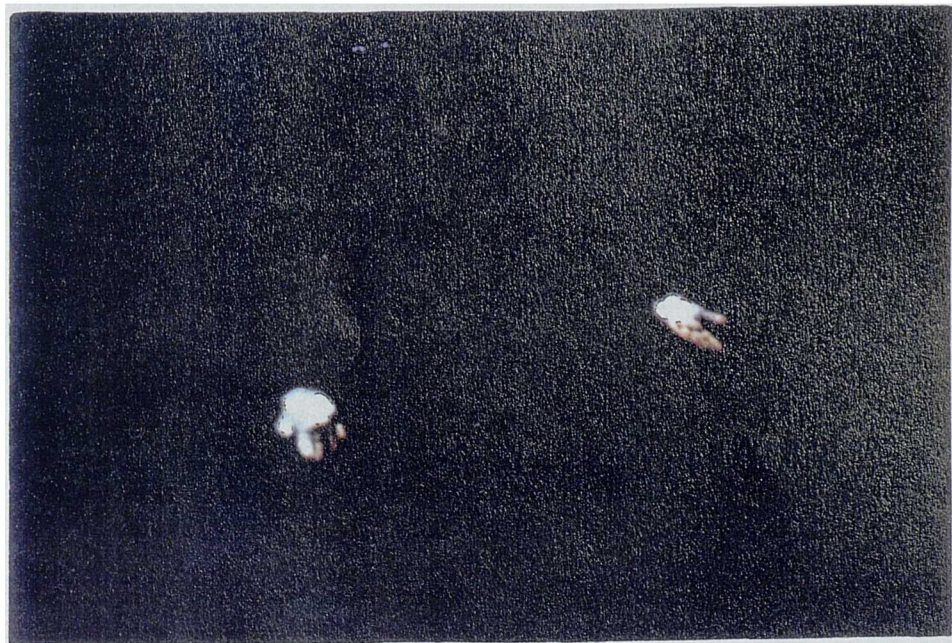
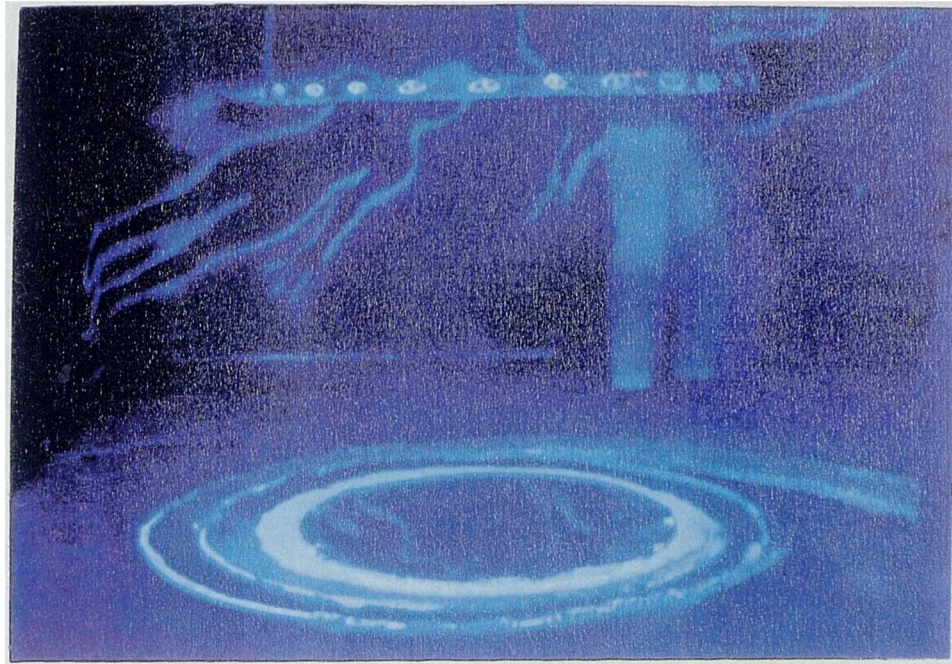


Fig 2: Stills record of Birth Dream Performance 1987, by Jane Prophet.

Top: The audience moving around the installation at the beginning of the performance. The large suspended disc was a mechanised drum, as it slowly tipped it made the sound of waves. The reflective disc beneath it caught the image of a woman in a foetal posture which was on the underside of the drum.

Bottom: In one part of the space a pool of deep water hid the performer, a shock went through the audience as my hands were lifted up to the surface illuminated by small torches. This was the first time the audience realised that the dark pool was inhabited and that the breathing soundtrack that they had been listening to for twenty minutes was live.

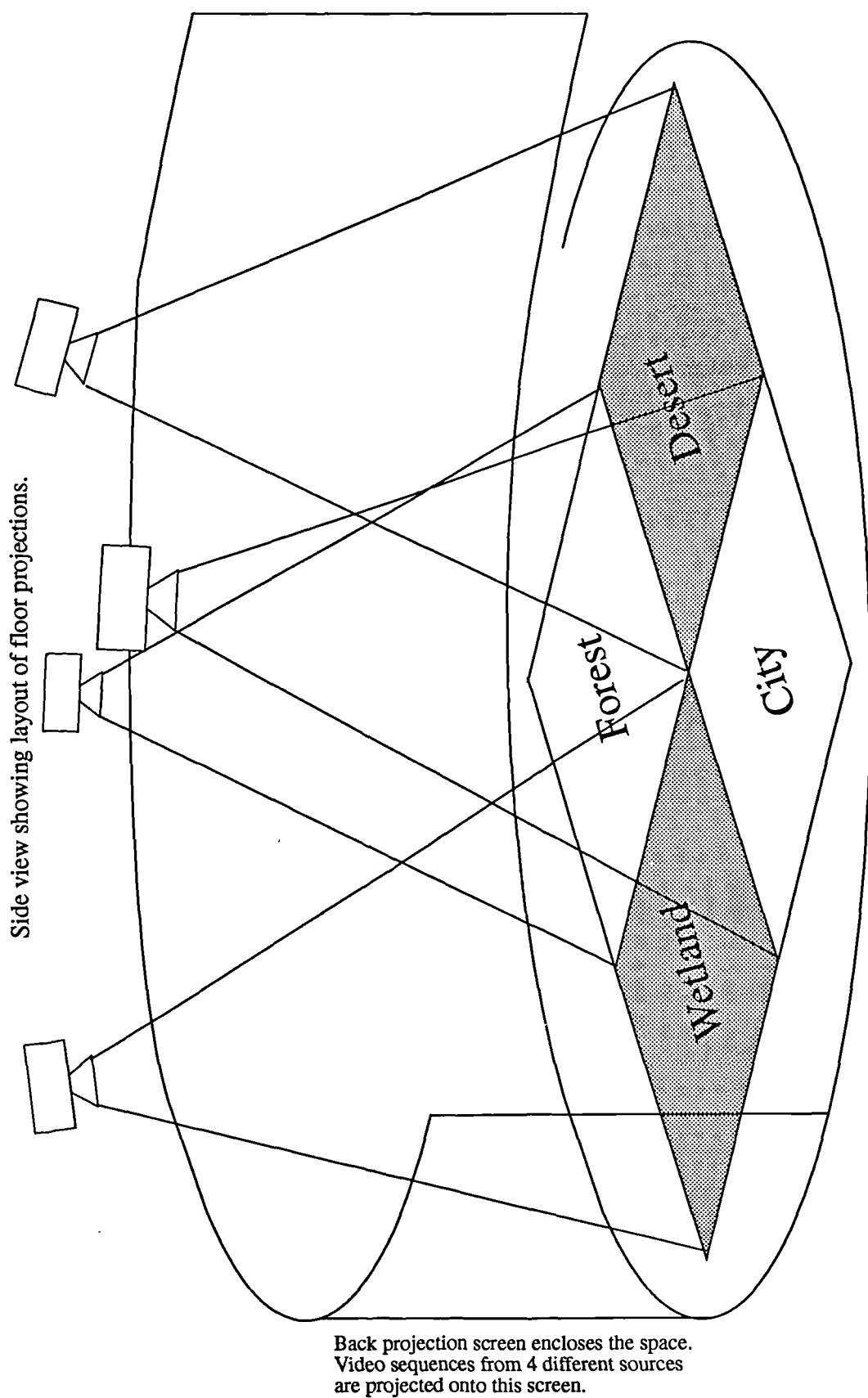
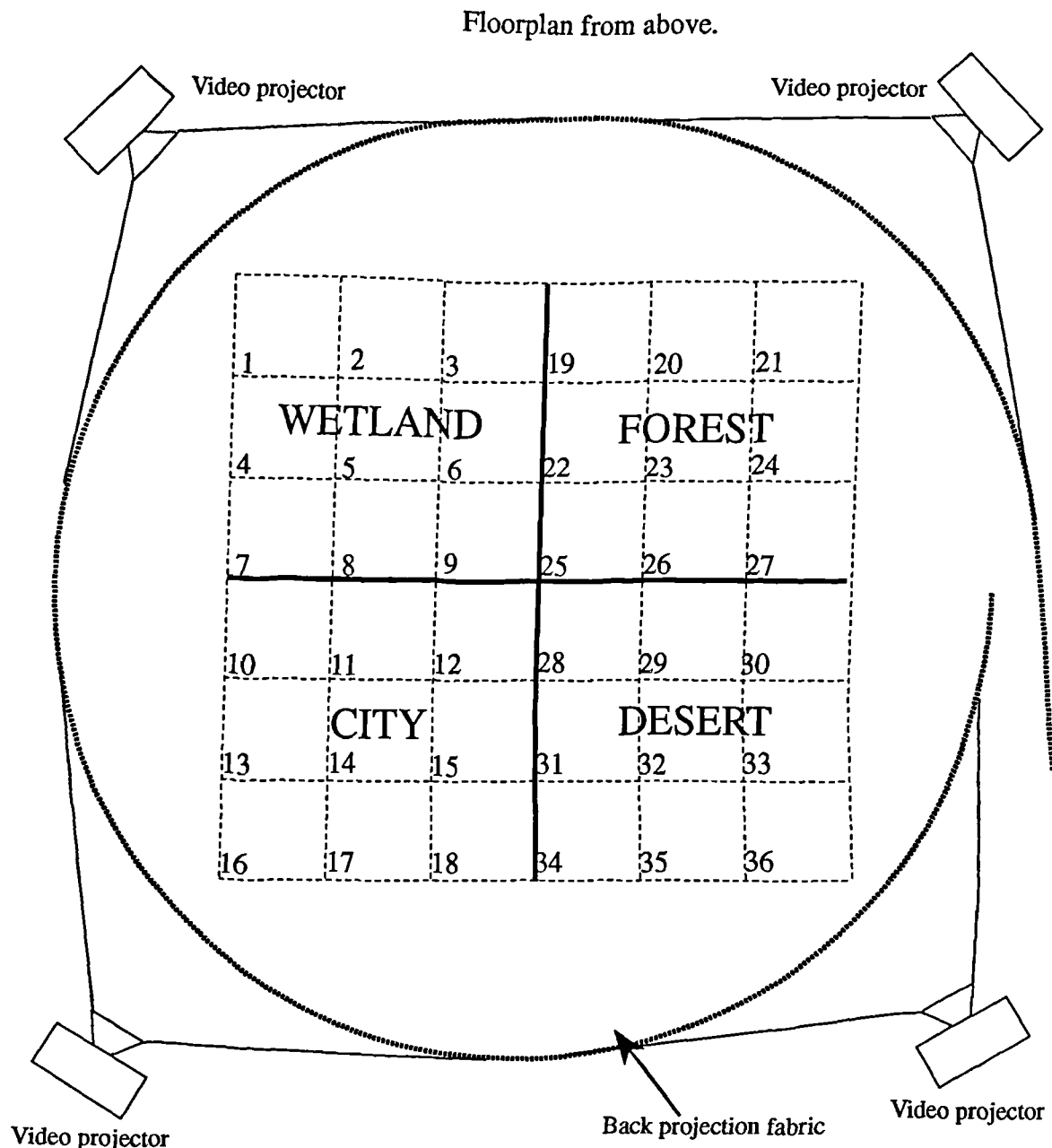


Fig 3: Nomad Zone, by Jane Prophet, 1992.
Side view.

Slides from 4 projectors above the space map out the zones, showing shifting tracks and paths through the space. These images will be produced by combining stills from videotape, scanned images, text and images from mini disc using Adobe Photoshop.



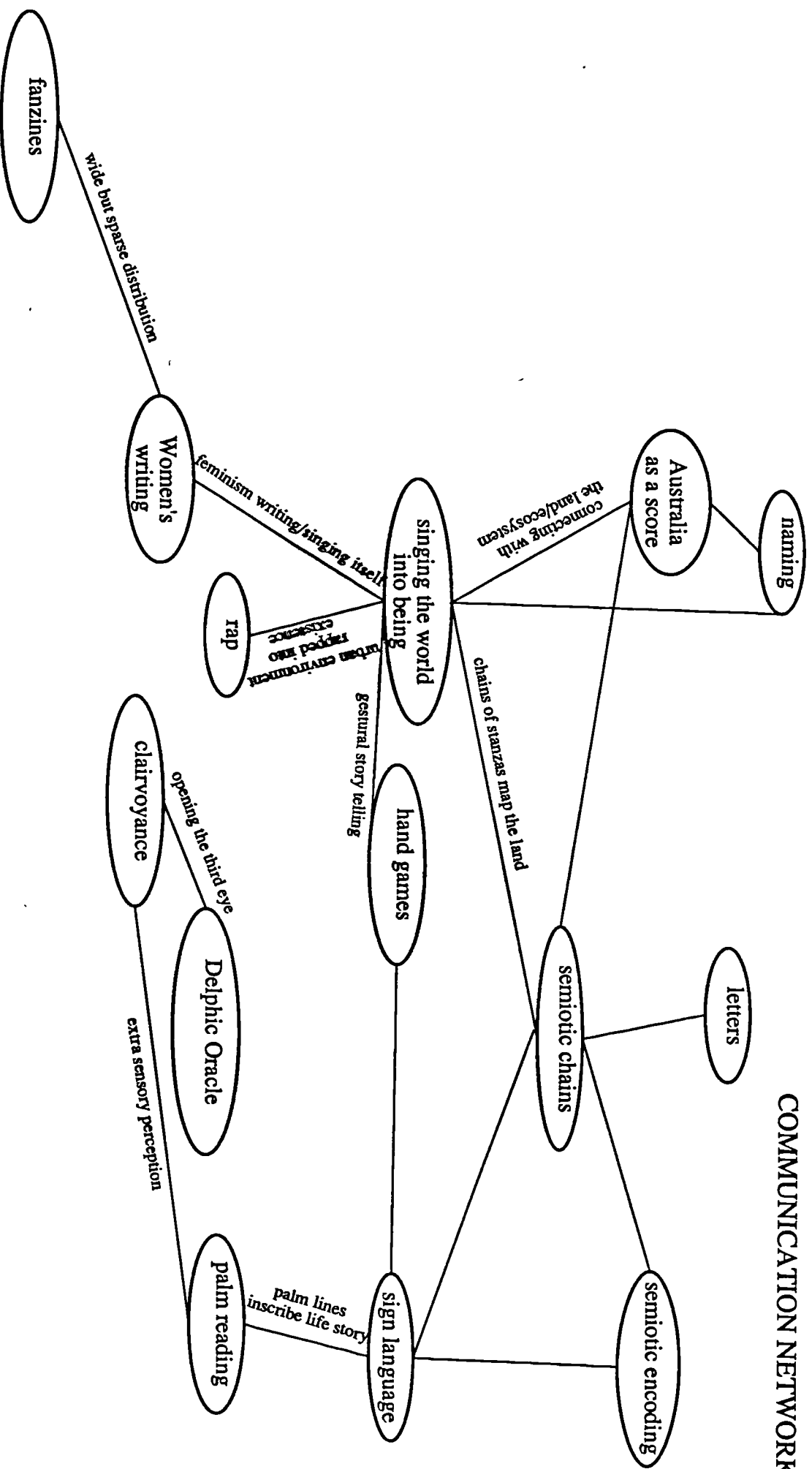
The dotted lines show how each of the 4 zones are divided in to 9 sections (the lines are not visible in the space). Slides are projected on to the floor and give character to each of the 4 zones. Each of the numbered areas is connected to a pressure-sensing pad. As the audience/participants step on to each section within the 4 zones their presence is 'sensed' by the pressure pads and a sequence of video and sound is played. Each of the 36 sequences of image and sound is between 30 seconds and one minute long.

Sequences are stored on videodisc for rapid access.

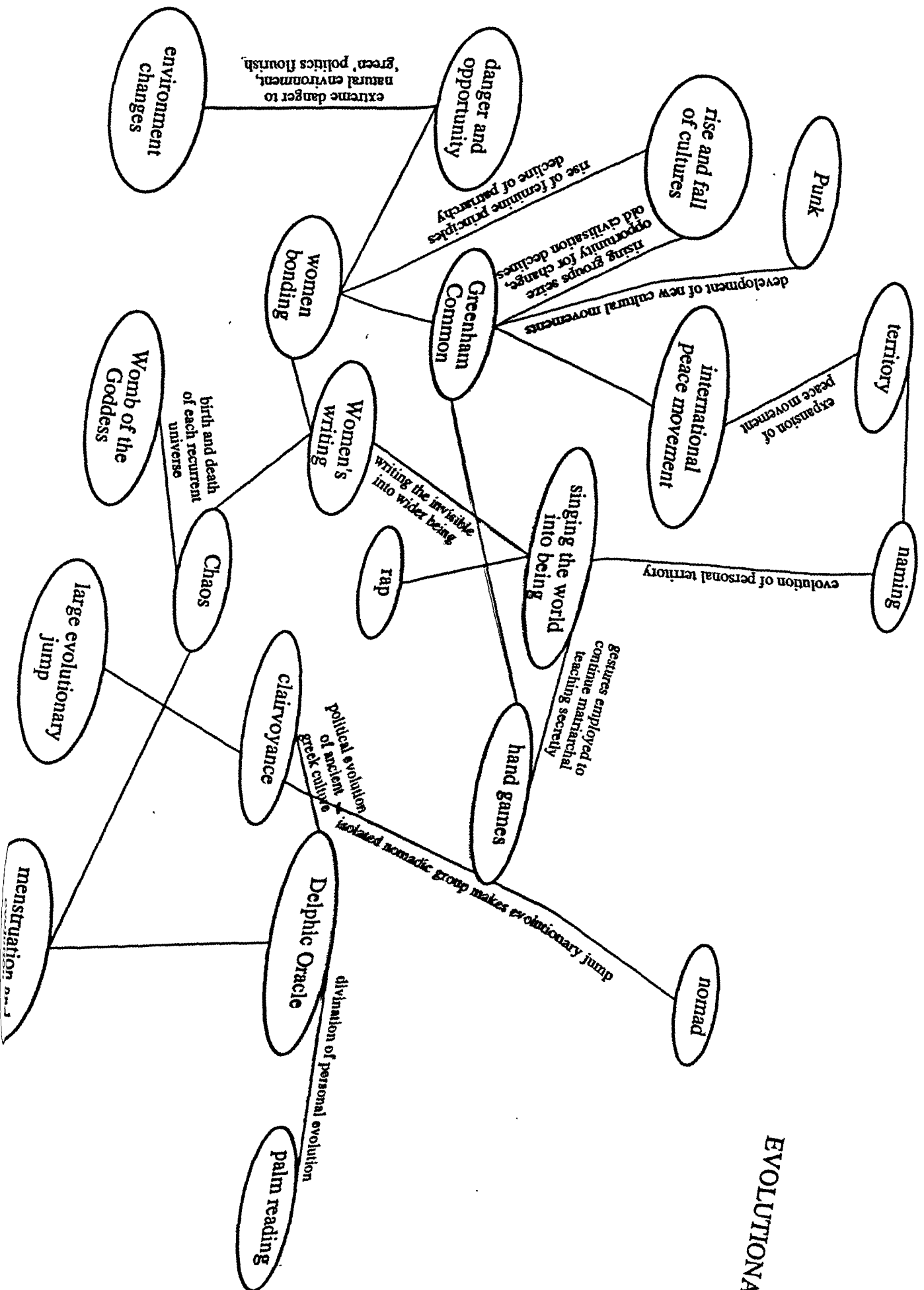
The sequences are back-projected on to the circular screen which surrounds the floor zones. Using 4 discs and projectors enables each zone to respond the a human presence individually and simultaneously.

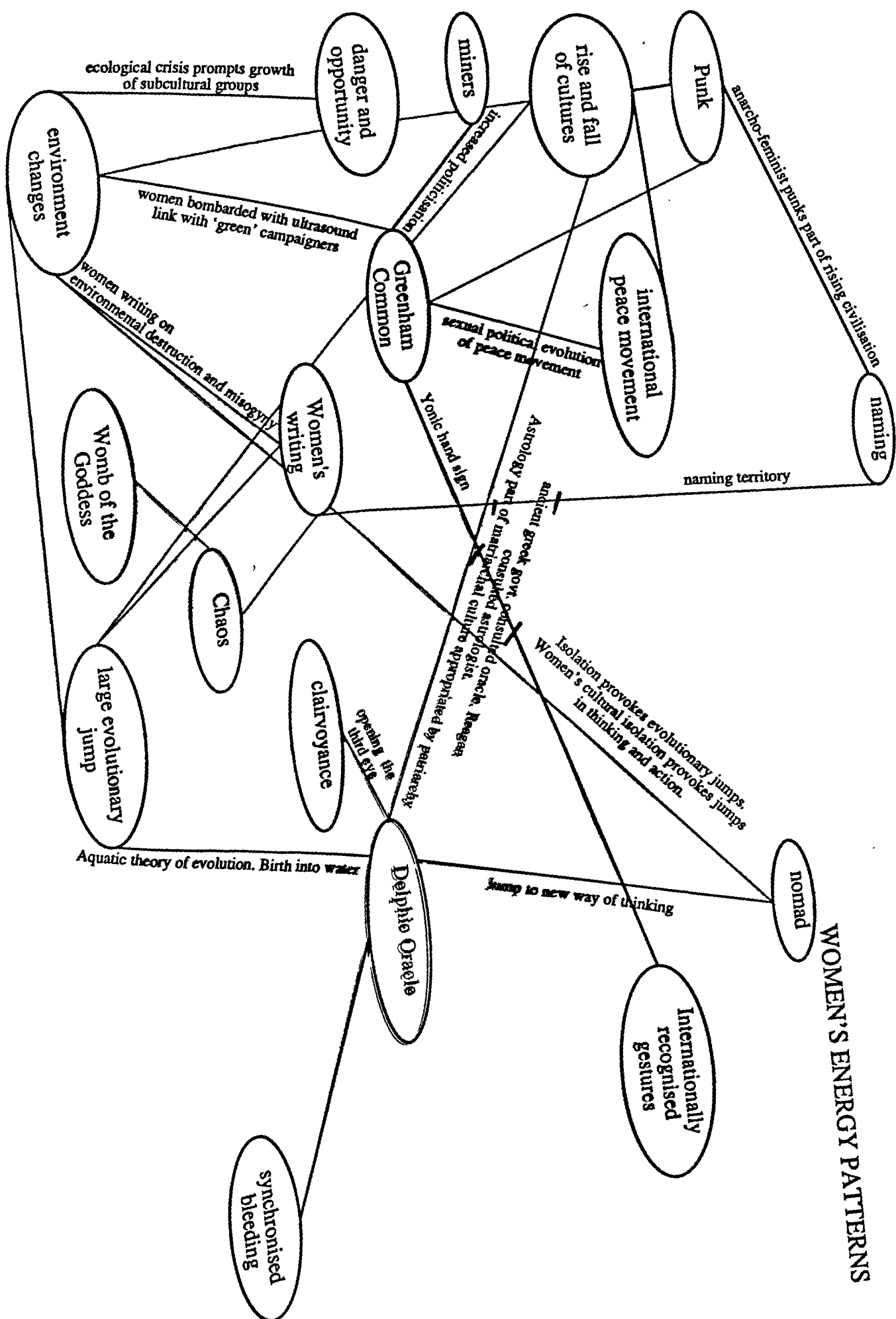
**Fig 4: Nomad Zone, by Jane Prophet, 1992.
Floorplan.**

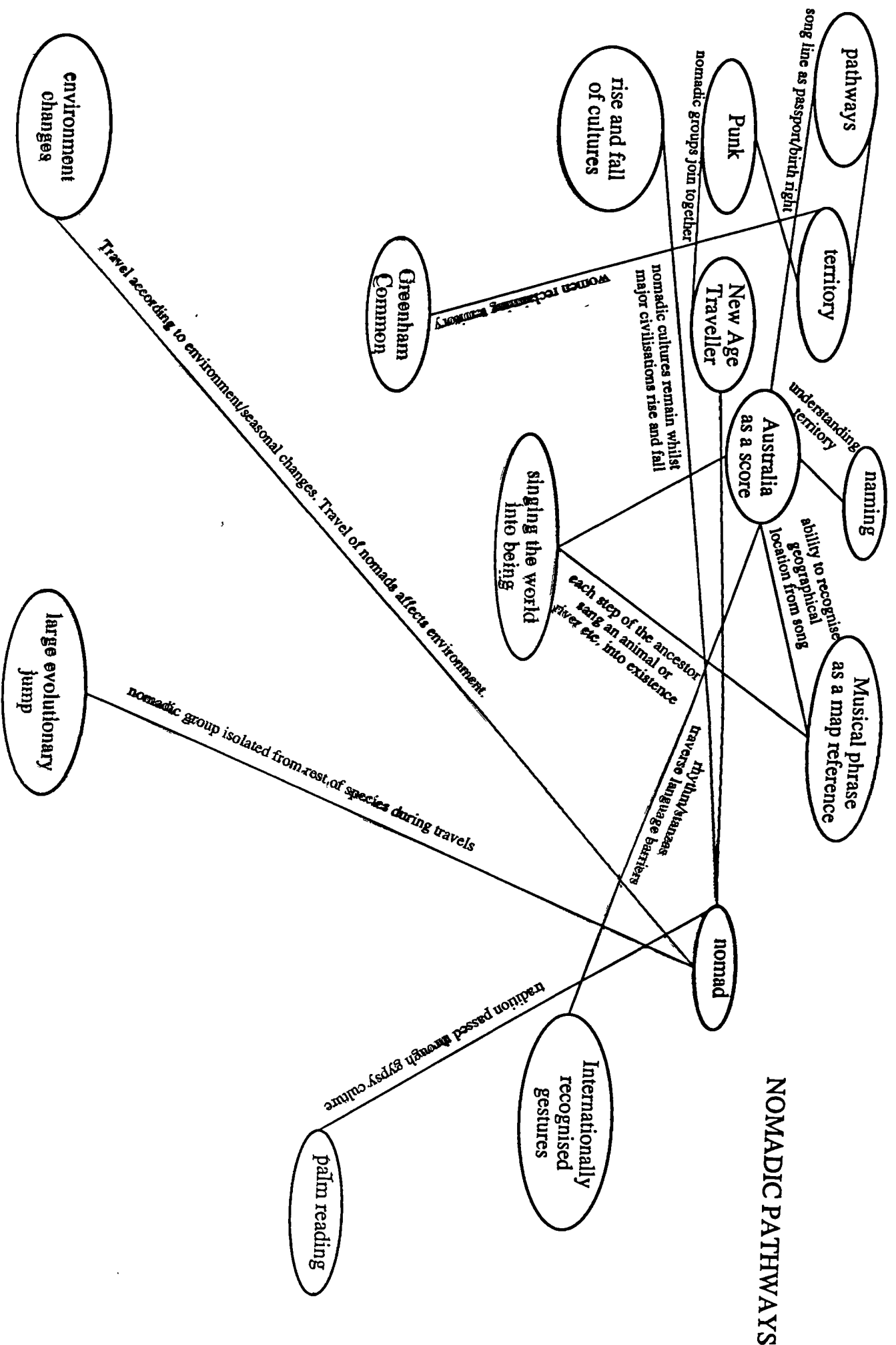
COMMUNICATION NETWORK



EVOLUTIONARY MAP







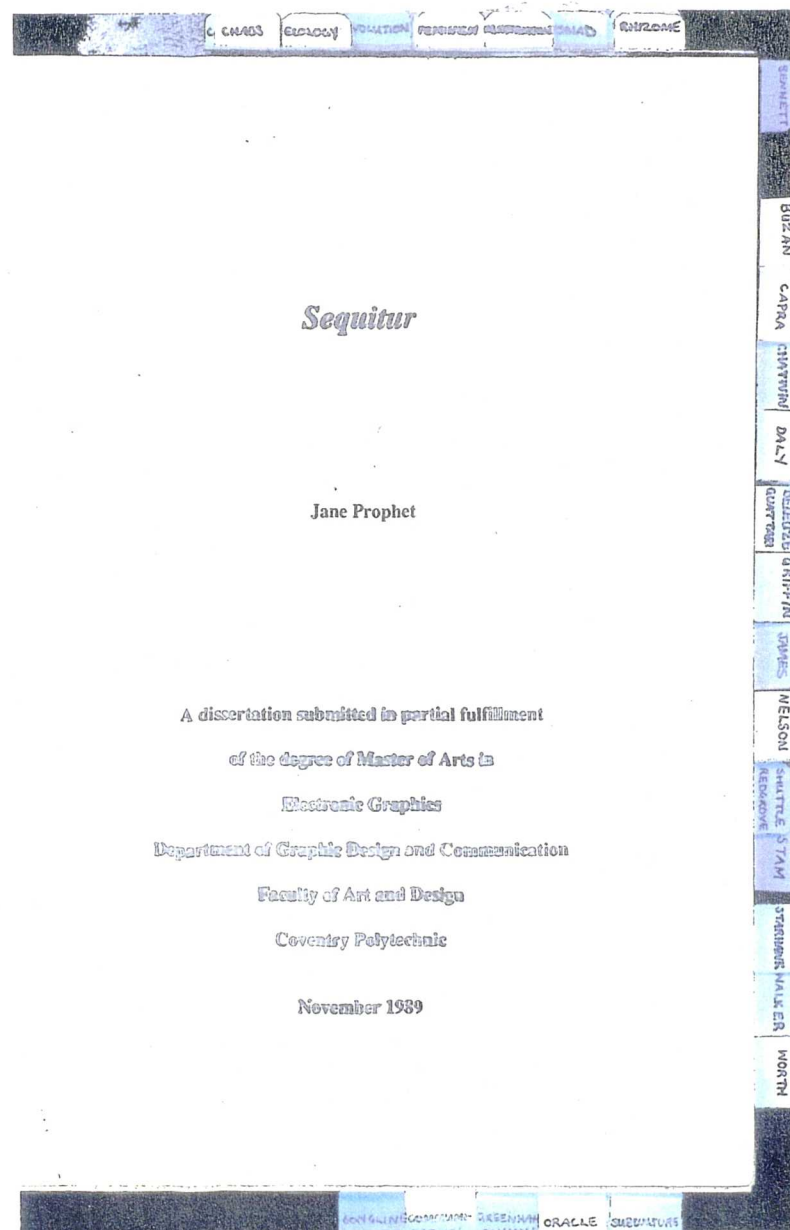


Fig 6: MA Thesis Cover, by Jane Prophet, 1989.
Showing the 'tabs' used to flick through the texts in a non-linear way.

THE ICONOGRAPHY OF KNOWLEDGE DOMAINS

The iconography of knowledge domains: an introduction

Electronic communication systems have taken the place of town criers or travelling storytellers in our global village. It is not necessarily what we say that is so very different, but that we can say it to many different people simultaneously across great physical distances. Our awareness of different cultures is increasing, and with it our ability to interpret signs, resulting in a growing recognition that the same “signs” can mean different things in different places. The expansion in electronic communication systems was claimed by Marshall McLuhan (1962) to herald a new way of thinking. With the advent of satellite communications, electronic mail and the fax machine, the exchange of information has accelerated, and this acceleration is an important characteristic of the new technology and central to theories of any accompanying new ways of thinking. McLuhan suggested that new information technologies will propel us towards becoming a global village where different “tribes” will communicate via satellite and computer: the ability to exchange information at high speed will in effect “shrink” the world.

It was the projected rise in the number of electronic links between countries that led McLuhan to talk of the “global village”. Changes in the international trading markets exemplify this; electronic and satellite equipment operates so rapidly that information dissemination has become as easy and immediate as it once was for one rural villager to talk and trade with one another. Today financiers all over the world watch their computer screens and see the same information virtually simultaneously. Deals are made and whether money is gained or lost sometimes depends on the split seconds that it takes for computer screens to regenerate with new text and figures. Indeed, this information exchange system operates so

quickly that human traders have not always been able to intercept the process at crucial moments. To capitalise on the advantage that the speed of computerised dealing gives them, programmers have built “fail safe” codes which monitor markets and automatically trigger the buying and selling of shares at given points, therefore removing the need for constant human intervention which slows the process down. Unfortunately these codes were not written with chaos theory in mind, and on the macro scale failed to produce order, for example the market collapse of the 1980s has been partially attributed to the automatic functioning of computers programmed to interpret and respond to the rise and fall of share prices. As the price fell below some theoretical threshold, computers sold in unison, precipitating a downward spiral. The near collapse of trade on Black Monday is an example of the speed of technology working against the global village. In response there has been a slowing down of the information exchange in the stock markets in order to facilitate human monitoring.

McLuhan began by focussing on the *speed* of information exchange as central to any change in thinking prompted by communications technologies. In contrast Cullingford places the emphasis on the potential for these technologies to promote more *interactions* between individuals, nations and businesses. Cullingford implies that the characteristics of these technologies function in a way analogous to human thought processes, and that, writ large, they also promote a rapid exchange of information through networks of people. He stresses the importance of the analogy, with a fully compatible new technology enabling us to forge complex webs of communications and connections. The high speed simply allows us more links and connections and a higher volume of information in the process.

The networking applications of computers have interested a vast array of people, from educators keen to use computers to facilitate students working in groups, to credit companies wanting access to cross-referenced lists of defaulting clients. My own central focus is how networks of data stored on computer can be of use and interest in art education. One place to begin is with the nature of the networks themselves, particularly those whose logic follows the rhizome rather than the tree:

“The whole logic of the tree is a logic of tracing and reproduction. ...It consists of tracing something given as already made, starting from an over-coding structure or supporting axis. The tree articulates and establishes a hierarchy of tracings, which are like its leaves.

The rhizome is something altogether different, a map and not a tracing. Make maps, not tracings...If the map is opposed to the trace, it's because its whole orientation is toward establishing contact with the real experimentally.”

Deleuze and Guattari (1983) p.25

This chapter begins by sketching my interest in non-linear networks of data, and includes a look at the interactive potential of hypermedia networks. Parallels have been drawn between the electronic networks of communication systems, the associative thought processes of the human mind and the networks that form hypertext or hypermedia environments. The relevance of non-linearity and the computer database (as opposed the linear sequential nature of the written and spoken word) are considered in the next section.

The popular implicit interpretation of the brain as a working physical organism, which can be traced to Descartes, underlies much current software programming. But the antecedents are more complex than this, in any event; the origins of hypertext packages reverberate with military research, cognitive psychology,

computer assisted learning and computer managed learning. Military research with its tendency to see people as predictable and controllable, has influenced education theory and practice, not altogether benignly, particularly the way that computer systems have been incorporated into the curriculum.

Excitement about the Virtual Reality systems, which have recently captured the public's imagination, is in part based on the Cartesian dream of possible escape from the confines of our physical bodies to roam through inner landscapes of our minds, long considered more valuable and sophisticated.

In the most radical of its potential formats, this whole thesis would exist as a database allowing the reader to jump from one piece of text to another, accessing video sequences or sound bites at will. Submitting the thesis as an interactive computer database would certainly have facilitated the inclusion of "live" examples of non-linearity, enabling the form of the information to follow the content. To produce such a document, software such as SuperCard™ or 4th Dimension™ (both Macintosh hypermedia authoring environments) could have been used to combine text with images and sound. This process is explored within this chapter, with reference to mapping a domain of knowledge (in this case colour theory) from paper to computer.

There follows a description of the theories behind the design of a computer assisted learning package for art and design students, created to teach students about colour. I chose colour as a topic because as a student I had found it a particularly complex and at times tedious subject to study. On the Art and Design Foundation Course which I took as a student in 1983, we were taught various colour theories and given copious notes on colour mixing and shading. The

practical lessons were separate from the information we were given about colour in art history, its psychological and expressive characteristics and symbolism. The design of a computer based package for learning about colour emerged as a response to this fragmentation. I have attempted to combine elements from practical, theoretical and historical areas in one package which could act as a supplement to both studio exercises and art theory lectures, and make the connections between these subjects more apparent.

In order for such packages to be of interest to Colleges and Universities, the role of interactive electronic media in education needs to be evaluated. In some institutions there remains support for the notion that once before a screen, be it television, computer monitor or film projection, a student becomes passive. Sue Van Noort is a nursery teacher from Sheffield who uses video as a teaching tool:

“I see the aim behind introducing video into the nursery curriculum as a beginning to media education, providing children with a opportunity to talk about and question their experience of television.”

Van Noort (1989) p.6

Van Noort believes that watching television, like playing computer games, is not a passive activity, and compares it to listening to someone reading out loud. It is widely accepted that children are not being passive while sitting silent and rapt listening to a story; by the same token Van Noort argues that watching television is active too, even if while watching children appear quiet and still. The internalisation which is taking place is not necessarily a passive experience.

Using video in the supervised nursery provides children with an adult who can answer questions and with whom they can discuss the program in much the same

way that they do when an adult reads them a story. The absence or presence of an adult or teacher, who is able to interact with the children as they watch television or play computer games, is underlined as a significant factor in the way adults perceive the unsupervised television viewing of their children as passive. Interactive learning packages have the potential to prompt questions and present issues relevant to the video sequences viewed. Though not as versatile as a teacher, such a package if well-designed can answer some of the most commonly asked questions.

Hypertext and the electronic classroom

Hypertext and interactive systems

The hypertext and hypermedia database system is a development which has great potential as a mechanism for creating both local and global networks of data. During the Second World War, Dr Vannevar Bush coordinated the research and development work in the USA of about six thousand scientists. In 1945 he wrote an article in Atlantic Monthly which called for the creation of a mechanical device able to retrieve information. In the opening paragraph of this article he appears fearful of the end of his wartime research, and concerned that nothing will seem as worthy of the research teams' efforts. Bush fantasises about a machine of the future, the "memex", that will be like a desk, with a keyboard, buttons, levers and slanting screens upon which images selected from encyclopedia will be projected. The "memex" seems to be a prediction of the cult of information technology, the function and even the approximate appearance of the contemporary computer. In Bush's "memex" desk, large amounts of materials are stored, compressed onto microfilm which the reader accesses via indexes.

Bush visualises the reader skimming rapidly through pages of text, stopping at any required part. Notes can be added wherever the user wants, and trails can be built by joining items together with their individual codes, “any item can be joined into numerous codes” (Bush, 1945, p.107). Bush envisaged lawyers, doctors and historians using this type of database. He stressed that the materials required to store this vast amount of information would be cheap, and that as a result literature would be economically available to more people. He surmised that the accessible nature of these storage systems would result in numerous and extensive collections of papers of scientific research that were easy to search through and consult. He presumed that having all published work within easy reach would reduce the replication of research. He dreamt that the “memex” would ultimately accelerate the growth of ideas internationally, partly as a result of reducing the replication of research and partly because access to recent research would be so readily available.

Twenty years later Ted Nelson echoed Bush’s vision of the future of the electronic office, but Nelson went further with his vision of the Xanadu™ database. Nelson stressed the advantages that an electronic network would have over the printed medium, the ease with which a group of authors could work together simultaneously on the same texts, and how simple it would be to link texts and exchange information with speed and efficiency. The similarity between the web-like structure of these networks and the associative thought patterns of human thinking were also of great interest to Nelson.

Nelson’s Xanadu™ was the first well-publicised design for a hypertext system. Xanadu™ would be a database held on computer. Xanadu™ is still in construction, decades later, getting more complex. Nelson’s original plan for a

hypertext system was to enable the cross referencing of existing writings, but this agenda quickly expanded to incorporate a function which would allow users to add their own comments and links. These links would result in a complex structure, made up of texts which might be linked associatively in some cases, while other links might conform to some classification theory, or the nature of the links themselves may be clearly marked. The way these electronic links work might be through a keyword which appears in **bold** type which can be activated by clicking on it with the mouse, or by touching it through a touch-sensitive screen. Once activated, the section of text relating to the keyword appears in a different window on the computer screen and can be closed when no longer needed. Alternatively the link may replace the current text with a completely different window of text. In this way the reference to one literary work, from within another, could be activated to access the referenced text.

Representing the knowledge domain

With simple domains of knowledge it is easy to present “concept maps” which illustrate the contents and the connections. These can be used as a basis for designing an electronic version of the domain. Once the domain is constructed on computer it is easy enough to provide a map which permits and charts whatever path a user takes through the web. As more information is added to a web it becomes increasingly problematic to represent the nodes (pieces of text or images) and links between them. Where there are hundreds of links the maps can end up looking like a tangled morass. One way around this problem is to generate a variety of maps for each web, each map having different characteristics. The map then functions like a guide with a given area of interest or a particular approach to the information held in the knowledge domain. Users can use these

maps to “filter” webs, and as a result gain information that is of relevance to their particular interests. Instead of putting together alternative documents (which is time consuming when dealing with printed material) authors can apply a filter, and one collection of texts can be filtered to produce a variety of smaller texts in different combinations. Using filters, coupled with the computer’s saving function, enables many versions/arrangements of the same information to be presented.

The author may want to create filters in order to present or print out only those sections of a body of work that are applicable to a certain reader, for educational, copyright or security reasons. For example, this type of filtering could have implications for those seeking to control the disclosing of medical records. Under the new Patients Charter patients have the right to view their records; however if a doctor deems information held in the records as likely to cause health-threatening distress, then the damaging information will be withheld from the patient. Information stored electronically can at the point of entry be tagged as accessible or confidential. The laws concerning privacy and access to information stored electronically are currently open to abuse, and electronic networking systems increase the danger of (mis)information being passed from one organisation to another. Electronic networking has meant that credit blacklists have been cross referenced, and individuals have suddenly found that they have been unable to get credit. On closer investigation they have discovered that their name has appeared on a credit blacklist, sometimes mistakenly, and that this list has been electronically passed around causing them to be blacklisted at numerous places.

Just as filtering can be used both to enable and restrict, so being able to save

many versions of a network has its disadvantages. With a paper document it is clear when corrections or changes have been made; pages may be marked or the sequence of texts altered. With a web it is not always so easy to spot the changes, especially as the computer provides us with tools that leave little trace of any changes (no smudges or crossings out here). When working on a machine with a colour monitor it is possible to assign a different colour to selected text, which makes it easier when working in teams for changes by each individual to be quickly recognised. If there is no colour then a different text **style** or font will often suffice, but changes to graphics or routings may not be so easy to define. Webs of linked texts, images and sounds can be put together with relative ease, structurally, associatively or even randomly linked. Constructing webs which represent particular areas of knowledge depends on the existence of at least relatively common understanding of what that particular knowledge domain should include and exclude. Indeed this is what is entailed in structuring a domain of knowledge although outside the settled conceptual apparatus of the so-called disciplines of knowledge it will be less clear that we are talking about domains, as opposed to other looser arrangements. In hypertext representations of settled knowledge domains the structuring of textual elements, images and sounds will always reflect the syntax of the domain, its array of key concepts and ideas. Some items will address this directly, others by way of example and illustration. Where the webs are linked associatively it is more difficult to define precisely each link, and indeed to justify the architecture of the network. On the other hand, highly structured areas of knowledge (such as a biological study of the human body) lend themselves fairly readily to being mapped.

What about the physical portability of the new knowledge stores? Computer-based webs offer reasonable, if privileged, access to users. While not as portable

as a single book, record or videotape, they are far more portable than a library, or libraries. There are not yet substantial numbers of large scale sophisticated databases, although libraries are adapting the interactive computer principle to the everyday running of their resources, using terminals for users to reserve, order and search for books which may be held at other sites. It will take time for a wide audience to acclimatise to using these networks and to become as comfortable and familiar with using them as they are with reading a book or listening to tapes or going to a lecture.

Associative thought and its relation to hypermedia

“The human mind ...operates by association. With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts, in accordance with some intricate web of trails carried by the cells of the brain ...Man cannot hope to duplicate this mental process artificially, but he certainly ought to be able to learn from it.”

Bush (1945) p.106

Bush made this statement as part of a plea for support for his proposed Memex design. Though his description of the way that the human brain works today seems simplistic and rather vague, it succeeds in exciting the unknowing reader (such as myself when I first read it) about the possibilities that computers might have for transcribing thought-webs. As I have mentioned, my own interest in this possibility was amplified because the idea of thought webs or trails seemed integral to the development of ideas for my art work. I often mapped these into sketchbooks and on the backs of envelopes, and the idea that I might be able to put them all into a machine and then connect them up, even add new bits continually, was very intriguing. It had the potential to supplement my usual way of creating idea webs which entailed collecting things I felt were associated with

the idea as it developed and reviewing it by scrabbling through sketchbooks full of loose sheets of photocopies, postcards, drawings, writings and collected oddments (which inevitably fell out and were sometimes lost). It was at this reviewing stage that an electronic database might really have helped.

Precise and detailed duplication of associative thought processes by computers creating webs of trails is impossible due to the sheer number of connections that the brain is able to accommodate and the speed with which the human brain jumps from one item to another. In the average brain there approximately 10,000,000,000 individual neurons, with each neuron able to interact with other neurons in many ways; there may be in a single brain interconnections between neurons of up to ten to the power of eight hundred. But the basic concept of associative connections can be applied to the design of far simpler versions of this type of structure to run on computers. Vannevar Bush identified a central trait of his proposed “memex” to be its ability to create trails which mimic these associative connections where

“any item may be caused at will to select immediately and automatically another. This the essential feature of the memex. The process of tying two items together is the important thing ...when numerous items have been tied together to form a trail, they can be reviewed in turn ...any item can be joined into numerous trails.”

Bush (1945) p.107

In Sequitur I attempted to reconstruct one of my previous thought webs, using pieces of text to represent each node of thought and using key words and labelled tags to make more than one connection between pages. If, as the readers went through the texts, their thoughts jumped to any of the subjects implied by the labelled tags, then they could flip to the relevant text. I hoped Sequitur would thus

lend itself to an individualised reading, with different readers taking different trails through the thesis depending on their own parallel associations. However, they were relatively restricted to the material and links that I had provided, and could not add their own.

Using computers to aid associative thought

It is widely accepted that computers can increase the speed at which it is possible to access source material about a given subject, but to see this as the computer's main or only function is to ignore the great potential that electronic media have for offering a variety of representations of the same body of material. Displaying material in a variety of configurations might make it possible to view a familiar subject in a new light. Acknowledging these possibilities depends on the acceptance that with them there might come a new methodology, which may lead to the development of a different pedagogy.

The way that different subjects are linked together in the design for the teaching package on colour permits an associative "reading" which similarly encourages a non-linear thinking and reasoning derived from the interpretation of a wealth of exercises, art historical critiques, colour theories and biographies. There is perhaps suggestive analogies with sub-atomic physics and ecosystems:

"An elementary particle is not an independently existing unanalysable entity. It is, in essence, a set of relationships that reach outward to other things. The world thus appears as a complicated tissue of events in which connections of different kinds alternate or overlap or combine and thereby determine the texture of the whole. The picture of an interconnected cosmic web which emerges from modern atomic physics has been used extensively in the East to convey the mystical experience of nature."

Capra (1975) p.151

“In truth, the understanding of ecosystems is hindered by the very nature of the rational mind. Rational thinking is linear, whereas ecological awareness arises from an intuition of non-linear systems. Ecosystems sustain themselves in a dynamic balance based on cycles and fluctuations, which are non-linear processes.

Capra (1983) p.25

These words from Fritjof Capra taken from his books on physics, science and society bear a strong resemblance to those written by Ted Nelson or Vannevar Bush on the possibilities and relevance of hypermedia systems. In our culture, where groups of people are striving for a broader integration of human needs and world resources, where both are seen as of equivalent value and connected in a broad range of ways, a computer system that promotes the connecting of isolated items strikes a chord with people who are in the process of re-discovering connections on a grand scale. Though, ideally, hypermedia systems might assist us to make more connections and better sense of our world, in actuality they are usually used to produce electronic versions of collections of materials used in the study of established subjects, or to make promotional collections for companies who want to combine the equivalent of slides, video, sound and text in one portable unit which has the added attraction of being the latest fad in corporate presentation techniques. The trails that have been built to record and prompt the creative processes, are few and as they have little commercial viability they tend to have a small distribution amongst known interested people.

One of the results of current changes in Higher Education is the emphasis on student centred learning. As Universities struggle to fund themselves they are offering places to higher numbers of students; lecture halls are unable to accommodate these increased numbers and staff are stretched to their limit. At

Sunderland University the response has been to investigate the utilisation of new technology to ease the strain on an overloaded teaching and tutorial system (CAL learning environments are supplementing and replacing some lectures). While these concerns seem noble enough, students and staff at many educational institutions are still campaigning for the computing facilities to do basic word-processing. At Middlesex University last winter there was a student occupation to draw public attention to overcrowding, student poverty and a lack of computing facilities. In art and design, interactive multi-media workstations are the dream of many, but within the economic grasp of very few.

The rhizome and the tree as two contrasting structures for the presentation of information

The tree and the book and linearity

Our communication techniques are heavily weighted in favour of linear sequential forms, which we use even to organise and communicate the associative, non-sequential processes of our memories and intuitive ideas. Speech restricts us to hearing and speaking one word at a time (unless it is recorded and multi-tracked to layer one section of speech over another). Words are emitted in lines and the medium of print follows this principle and makes it more tangible by arranging the lines of words in consecutive rows, which eventually accumulate into the serial to form books. Hence the format of the book or standard lecture is linear and sequential, a tree-like form which may branch away from the central theme but whose branches do not interconnect. A footnote may take the reader branching away from the main text, as do references to quotations, but after perusal the readers returns to the point at which they left off to continue through

the text. Using hypertext or hypermedia authoring systems on a computer enables the author to include referenced texts, images and critical analyses more fully.

The users can digress further from the main text, and indeed may not return to the initial point of digression, as their path of exploration takes them towards another text or image:

“The linear format forces the author/speaker to choose which piece of information to give first and which second and so on, in a sequence. The position of one piece of information in such a sequence of texts/images affects the reader’s interpretation of it. This positioning of one block of text in relation to another is the technique employed by authors to create narrative. In order to generate a narrative in this way the author assumes that the text will be read sequentially.”

Prophet (1989) p.1

The standard linear sequential nature of the printed book can be interrupted by the author with the use of footnotes, references glossary, contents and index, all of which allow the reader to digress from the linear narrative. Not all books rely on a strong narrative form, and though most depend on linearity; some are written for browsing through, picking out certain sections here and there. These cannot rely on an unfolding narrative, but must go some way towards presenting texts in smaller nodes which make a sense on their own (though they may mean more the more that the accompanying texts are read). The most obvious example of this type of book is the dictionary or encyclopaedia, typically arranged item by item in alphabetical order.

Hypermedia, the rhizome and non-linearity

“Let’s sum up the principal characteristics of a rhizome: unlike trees or their roots, the rhizome connects any point with any other point, none of its features necessarily refers to features of the same kind.”

The rhizome is an organic structure, in the form of an underground stem, distinct from roots and radicles. Rhizomes are found in natural forms like those of the bulb and tuber, they spread in many directions simultaneously, forming an interconnected rhizomal network. The largest known living organism is an ancient rhizomal fern which has grown rhizomally for centuries and now covers many acres, the whole structure connected and related. As a structure the rhizome is analogous to the neural networks of the human brain, making connections and growing into a complex and vast organism. It was the dream of producing a machine which could be used to present information in a similar way which led to Vannevar Bush's article in 1946. My own interest in the rhizomal structure grew out of a need to decipher and log the connections which occur during the development of ideas for my video art work. The more I tried to trace an idea back the more it seemed to be made up of many entangled and connected elements, without a single neat line through it.

Just as some books do not conform to a linear narrative sequential format, so hypertext is not intrinsically non-linear or rhizomal. A linear sequence of texts can easily be made into a hypertext document, resulting in a direct transcription of the standard book format. There is no challenge to the concept of authorship in this type of presentation, and no choice of paths through the domain. More interactive versions of the electronic "book" enable both the author and the reader to weave additions, like those found in footnotes and references into texts, blurring the divide between author and reader at the same time as reducing the distance (both physical, temporal and critical) between the main body of text and any subsidiary texts. The scholar is thus aware of existing connections between

texts and can make her/his own additional links (Landow,1989), (Nelson, 1987).

Most loosely structured domains are made up of a combination of hierarchically connected elements and elements which have more serendipitous links. How these domains are presented depends greatly on the instructor, who may choose to present elements in a highly structured sequence or in a more loosely connected manner. Using hypertext to present domains does not automatically restrict this choice of presentation, since hypertext is simply a tool or medium for presenting knowledge domains, though it makes it relatively easy to produce non-linear presentations. Rather than using OHPs, video players and numerous connected texts on paper, all these approaches can be combined in the hypermedia environment.

The addition of functions which allow the person using the package to add their own text and/or images further blurs the traditional distinction between “author” and “reader”. It becomes less possible to predict the route that may be taken through a collection of visual information and the author relinquishes a certain amount of control. Linking scholars together via networked workstations, multi-user or time-shared systems opens up a way for a group of people to work on the same text with relative ease. Using these types of systems, it is possible for groups to communicate with each other as they work by sending electronic messages (which means that they do not have to necessarily be in the same building or even the same country). Co-authoring and annotating texts re-defines “author” and “text”. Hypertext documents can be assigned different levels of accessibility, so that individuals can view and alter one another’s work where authorised. The static nature of the printed book and its traditional storage in the library does not provide readers with such ease of movement between texts and

precludes annotation (or limits it to tantalising scribbles in the margins). In addition to speeding up and freeing the flow of written information, interactive computer databases provide opportunities for the integration of graphics, animations, three-dimensional computer models, sound and video sequences with texts.

Subjects presented using hypermedia programs do not have to rely on a traditional linear sequential reading, although the author can present information in a way which depends upon the user experiencing the material in a linear sequential manner. It is possible to define the links between blocks of information in such a way as to preclude certain sequences, by making it necessary to negotiate some blocks of information before others can be accessed. This results in the inclusion of pockets of linear sequential trails. Although these may be necessary to ensure that vital steps are not missed out by the user it is important to remember that even a fairly inexperienced user will soon know how to skim through areas s/he is not interested in.

Their non-linear character is what initially attracted me to hypertext/hypermedia programs. Having experimented with making video artworks, the ways in which different people interpret, differently, sequences of images interested me: the way that the same set of images placed in a different order resulted in a different gestalt was an equally fascinating aspect of video editing. When talking of a different “gestalt”, I mean the optical illusion whereby an image can be radically and swiftly changed by what is seen before or after it, by what one hears on the accompanying soundtrack, or by the inclusion of a superimposed caption (much in the same way that the well-known Gestalt image (see Fig. 7) suddenly changes from appearing to be an old woman to a young woman; the image itself does not

alter, it is just perceived and interpreted differently). Hypertext provides the opportunity to present texts in a similar form but with versatility and variety. The result is a digital network of elements which can be rapidly accessed, whereas video works usually end up on a linear strip of analogue tape. Video stored on laser-disc may offer an alternative to this. Like audio CDs, the video-disc facilitates random accessing of sequences. Each image, or group of images, is coded and by using this code a chunk of visual data can be displayed rapidly. As video discs become easier and cheaper to produce, the opportunity for easy-to-access video sequences within multimedia packages, or for using multimedia authoring programs to create interactive video installations will improve.

Using an authoring system which enables the combining of texts, still images and moving images in a non-linear manner has been said to mimic “the interwoven system of ideas” (Nelson, 1987 p. 14) which forms the structure of thought. The predominantly non-linear format of hypermedia packages allows the user to jump from one piece of visual information to another, without the constraints of a linear “reading”. When designing computer aided learning packages with these tools it is possible to provide a diverse range of information about a given subject. There can be many nodes of text and images, each making sense on its own, but variously connected to other nodes of information. The connections between nodes may change or develop the users’ sense of other nodes. As users explore the database their route through the texts and images could be one of many combinations, depending on which route is taken from one node to another. The package is like the rhizome, a collection of points of information many of which are linked together.

The multimedia potential of electronic webs of information is currently receiving

copious attention both within education and commerce. As the computer industry allocates more funds to this area, so the tools needed by non-experts to create multimedia webs develop, resulting in more advanced and less cumbersome multimedia authoring packages. "Multimedia" has become a buzz word, equalled only in hype by the ubiquitous "Virtual Reality". As hardware and software companies compete to corner the market many authoring systems on offer are not capable of combining different media without expensive additions, and even then they can be very difficult to orchestrate. Current multimedia computer systems are tools with which users can create environments using text, video, sound, three-dimensional models and animation; they aim to make each of these elements as editable as the text in the webs already described. Just as icons or words can be activated to access a linked piece of text in hypertext networks, equally a sequence of video or sound, stored on tape or disc, can be brought into view or hearing by selecting an icon or word. Many packages available at the moment are still complex and unwieldy for the user who is not used to programming, though there are moves towards developing more intuitive designs for these authoring packages. For £700 it is now possible to turn a PC into an advanced multimedia environment capable of combining stereo sound and on-screen video.

Much of the design for the CAL package on colour is structured in the form of a rhizomal network, but parts are tree-like, hierarchical. These sections are "constrained nets", areas of the knowledge domain where certain pieces of information become prerequisites that the user must pass through in order to access the main collection of images and texts.

When a particular text is linked to an article that it cites (for example when a

graphic of the work of a painter is linked to the colour theory it illustrates and that explanation linked to a biography of the colour theorist/scientist) the initial text becomes part of a larger network or web of ideas and texts. The whole, consisting of all these disparate parts, may well mean more than the sum of each element. It invites readings of individual texts which exist integrally within the context of meanings derived from the other texts that are linked to them. As trails are made through these texts the focus of the reader's attention or the direction of investigation can constantly shift,

“...hypertext provides a infinitely re-centerable system whose provisional point of focus depends upon the now interactive reader.”

Landow (1989) p.175

The user can work associatively within the knowledge domain, and by accessing a map of his/her path through the domain, can return instantly to any of those nodes at any time. Presenting knowledge domains as webs of related texts opens to question the traditional reading of texts, which prior to hypermedia could remain separate and distinct from the critiques of them and their modes of production. These types of network also challenge the boundaries between author and reader: annotation permission enables a hypermedia network to evolve from the collection of data which the author initially presents and defines, so that in effect the readers can substantially diversify the story-line or trails, and introduce new characters and elements. With or without these changes, it is no longer the author who directs a readers' "journey" through the texts, but the readers themselves.

As the distinction between readers and authors blurs so does the divide between individual texts. Just as the blurring of author and reader challenges the omnipotence of the author, so the blurring of texts challenges the notion of the

canon with its tendency to see authorised versions of texts as aesthetic monads. Landow (1989) describes this process as “democratisation”, a flavour which can be seen in the work of students who make videos on Fine Art courses. They often begin by accumulating “found” images and democratise these images by, for example, appropriating broadcast material into their own work or re-editing initially separate sequences, to give a new meaning. They create electronic artworks in the tradition of two-dimensional collage and montage which themselves function in a parallel way by recontextualising image and text. Visual and text icons are increasingly being seen as common property, and as popular culture acquires increasing credence, the distinction between “high” and “low” art and literature is eroded. Plagiarism is redefined as “homage” in relation to the erstwhile author, “recycling” in relation to the material.

Eroding the delineations between texts can be viewed in two opposing ways, either as an erasure of the barriers that hold texts in isolation from each other, or as an abuse of the self-contained independence which some hold as a major quality of the book (Ong, 1982). Using computer based multimedia and hypertext packages allows the erosion of barriers between texts, and scanning machines enable large portions of text to be copied rapidly from book to computer. But with these systems the resulting conglomeration of information, while woven together and interdependent, retains a sense of independence from the user. It remains self-contained because though the user may add to it and alter its structure, the interface between user and machine - the screen - reinforces the separation between the two, keeping the database “other”. With the advent of so-called Virtual Reality (VR) systems, the erosion of this self-containment may become complete. If characters in books can be represented by graphical images with which the user can interact, and which can be changed at will, then the sense of

“otherness” that the computer screen maintains may be traversed.

Summary

The tools that are used to build electronic learning aids bring with them a collection of attributes which affect their application. These characteristics are not simply those of configuration and mechanical specification. Even before we begin to use them, these machines are gendered and imbued with strong cultural messages relating to status, dehumanisation and the state. To align educational goals closely with these media is to incorporate technologies that have been developed primarily for military use and adapted for educational application. In wholeheartedly accepting these tools into the classroom, we may be inviting other aspects to enter simultaneously that would be better left outside,

“In order to improve instruction and in order to legitimate their profession, through the incorporation of new technologies and the latest application of “scientific” research, the schools have unwittingly welcomed the Trojan horse of military prerogatives within their gates.”

Noble (1989) p.32

Educationalists would be wise to develop an awareness of the history of these technologies and the goals of their designers in order to adapt them more selectively to use within a curriculum that has very different aims and teaching methods to those which triggered the original research into machines as substitute teachers.

On a more positive note, the potential for creating non-linear interconnected webs of information using a variety of media is as exciting as it is exacting. The “fun” element associated with computer games and simulations is being used

increasingly when educational packages are being authored. With the gradual introduction of media studies at levels as early as nursery schooling, the role of electronic media may begin to be raised from its place as the traditional end-of-term treat (which carries with it the implication that, for example, watching a video is not “real” work) to play a fuller part in the curriculum.

**DESIGNING A COMPUTER AIDED
LEARNING PACKAGE:
TO TEACH ART AND DESIGN STUDENTS
COLOUR THEORY**

As a Foundation art student, and more recently a lecturer in Foundation Studies, I have experienced both the learning and teaching of colour theory in the same educational institution. Though six years separated the two experiences, many of the techniques for teaching this subject were the same and the problems had changed little. In addition to the colour theory of paint mixing and additive colour combining that I had been taught, there is now a need to teach students working in video about how the primaries of light are mixed, and how they contribute to the make up of a video signal. This duality is beginning to have a profound effect on the teaching of colour theory.

As a student the colour theory I experienced was fragmented, each discipline (art history, painting, print-making, design) contributing its own theory of colour with different subject tutors addressing colour and psychology, colour symbolism and the aesthetics of colour. Since issues of fit and coherence had not been addressed, there was a lot of repetition and some confusion. In general, the subject of colour mixing was greeted by students with groans. It was seen as a necessary low-level technical exercise which had to be completed before the “real” painting or printing could begin, and the lengthy “explanations” thought necessary were experienced as tedious. Only with the textual analysis of colour in art history did the “theory” seem more relevant.

This thesis is particularly concerned with electronic media, and in the spirit of action research I begin here with a programme that I designed to run on a Macintosh computer, to introduce Foundation Art students to the subject of colour theory. The package covers practical areas, such as mixing paint and colour in the printing industry, but also cross references subjects like colour symbolism and colour therapy. I have written above concerning how non-linear networks can be

used to present texts and their application as an art medium; here similar networks for structuring data have been used in an educational application. I believe it to be an instructive example.

The final part of this chapter charts a different application of colour theory, one that arises directly from the use of electronic media. In the process of producing video sequences the colour signal can be used to isolate certain colours in order to combine more than one sequence of video. New digital techniques have greatly increased the speed and reduced the cost of compositing moving images in this way. My own work has concentrated on an analogue approach to this technique, called “chromakeying”. An understanding of colour signals is imperative for this kind of technical and aesthetic exploration, which has taken the form of chromakeying through different materials, in particular using liquids.

Design considerations

As a lecturer I realised that it was not just the students who disliked aspects of colour theory, but that my colleagues who taught colour theory also groaned at the thought; they had to repeat the same exercises every year and they were well aware of the lack of enthusiasm from the students. When I asked them what they thought of a CAL package to supplement practical studio work on colour mixing they were both interested and reticent. On enquiry it emerged that their reticence was related to what has been described as a prejudice against CAL, not as a technology, but as a tool for

“...those who would see education as nothing more than the transmission and acquisition of subject matter, and who see the computer as nothing more than an instrument for making education more efficient.”

Kemmis (1976) p.2

My idea for the package was partly motivated by a wish to make the teaching of colour theory more efficient, by making the applications of the subject more transparent, and by attempting to integrate the different applications in order to engage students with a subject which they were frequently avoiding (thereby the teaching of it necessarily became inefficient as staff had to repeat lessons with small groups). Integrating and mapping the different areas that make up the knowledge domain was an intellectual priority, and I decided to do this by cross referencing the key ideas to the rest of the Foundation Course (for example directing students to textual analysis of artworks in art history or to exercises in making their own dyes from common plants). Although I categorise this package as computer *aided* learning, it shares some of the characteristics of computer *managed* learning systems in that it directs students towards studio exercises in, for example, paint mixing and tutorials with tutors. Inquiry, drill and practice and problem solving are also included in the design.

Although Charity James' work on the "fourfold" curriculum in the sixties was a reappraisal of secondary school education, some of her ideas have more general application. Her work on so called IDE (interdisciplinary enquiry) envisaged students developing an engaging and active relationship with the environment. I took this as one of my inspirations, although without going all the way with James who at times seemed to hold the view that the only valid structures in education are those produced by children whose natural enquiry roams in a way uninhibited by subject boundaries. James took a generous view of student autonomy, believing that the curriculum should be diverse enough "to allow different [students] to arrive at different points by different routes and at different times" (James, 1968, p.125). James is talking of the curriculum as a whole, but it

seem to me that this approach is also appropriate at a smaller scale. This espoused versatility was a key consideration in the CAL design, the aim being to produce a package which could either be used extensively at one sitting or could be dipped into, or would allow one or more areas to be explored in isolation. Another of James' emphases is on the sense of a student becoming at home with a subject area rather than learning subject-matter. In a practical art course such an understanding of the use of colour is essential, and to develop this relationship with the subject demands that it be related to a variety of connected disciplines. Reflecting on motivation, James lists answering other peoples' questions and working to others' design as important, and places an emphasis on the relevance of subject-matters that are to demand a long-term respect from the student.

Throughout the development of the design I tried to bear these points in mind. Foundation Art students are used to working on assignments and during the course they begin to work on outside design projects; the package could be used as a reference source during the research for these types of studies, from giving practical instruction on colour mixing and the psychology of colours to referring students to key texts. The long-term respect for a subject area is something more difficult to evaluate, but the use of new technologies does not of itself offer spurious guarantees.

The subject of "colour for art and design students"
as a knowledge domain

From my conversations with students on BTEC Design and Foundation Art courses at Mid-Warwickshire College of Further Education it was clear that colour theory was most interesting to them in relation to the psychological and

symbolic readings of colour and that cultural anecdotes about the emotive properties of particular colours were commonplace (black for death, red for passion and so on) and were taken into account when students worked on practical visual projects. Analysing the cultural foundation of these conventional readings also proved to be of interest and prompted discussion and cross-cultural comparison (that white is the colour worn for mourning in other countries etc). Through a textual analysis of paintings from different periods and cultures it is possible to raise these issues and to chart the chemical breakthroughs that led to some colours being valued over others and to the development of new and different colours. The colour mixing exercises were the least popular, and after discussion I decided to try and combine all the areas in one package. Bringing together the fragments of colour theory and mapping the potential connections between these areas was one of the goals.

The first task of the design process was to determine which aspects of colour theory to include in the package, and then how to combine these areas. The Foundation Art students towards whom the design was directed were my first consideration, since their needs would to some extent determine choice. Through discussions with staff who taught in different subject areas, I ascertained that the design would need to be wide ranging to fulfil the needs of such a diverse and interdisciplinary course. The course covered such diverse areas as the four colour separation process in printing, the temperatures and mixing of light when recording video or taking colour photographs, the chemical make-up of colours for dyeing cloth in fashion, the mixing of paint and the development of pigments in painting. Underlying these particular focal points was a general concern for the symbolic and expressive use of colour in art history and its relevance to practical workshops. It was a vast area to cover with students working in small workshop

groups that changed during the year.

Hierarchy/tree or network/rhizome?

A diagrammatic representation of the knowledge area often proves useful in the construction of courses of study, particularly when they seek to be systematic or “systemic” (Pask, 1972) and where the involvement of computers generates an aspiration for the map of the network to be in some sense held in the machine. Ordinary teaching necessarily involves at least an intuitive map, though this may not be well articulated. Computer Aided Learning (CAL) and Computer Managed Learning (CML) rely on a machine to represent a knowledge domain such as the use of colour in art and design, building the presumed structure of the knowledge into the program. When discussing the representation of areas of knowledge, consideration must be given to the internal logic of the subject to decide whether it can be represented by a hierarchical structure or not. The way that I organised the knowledge domain of the subject of colour for art and design students appears tree-like, hierarchic, in relation to particular aspects, but overall is an intuitive model with generous permission-giving to legitimise alternative connections and routes. It eventually was clarified as a network of ideas, exercises and information fully consonant with the notion that human knowledge is a

“system of interlocking mutually supporting parts”

Gellner (1959, Words and Things) cited in a paper by
MacDonald Ross (1972) p.5

Art and design students typically learn about colour theory within a largely practical course, involving the integration of colour theories with practical colour mixing exercises and art history. Mapping the interrelationships of the diverse

aspects of colour theory is complicated because the boundaries of the subject matter cannot be easily or precisely determined. As a domain, colour theory in art and design reflects what Hirst calls a “field” of knowledge, a broad domain characterised by a need to integrate approaches from various contributing disciplines. There is a need also to cross the boundary between objective and subjective aspects. For example, the physical function of the human eye can be linked to the colour theorist Michel Chevreul, and he to Pointillist painting and this to the artist Georges Seurat. The necessarily interdisciplinary flavour of colour theory implies a CAL database made up of a combination of tree-like structures and rhizomal networks.

The “field” of colour as taught to art and design students at Mid-Warwickshire College of FE is made up of several themes: the physics of colour as reflected light; the function of the eye in perceiving colour; the psychological, emotional, behavioural and physical effects of colour; the production of colours through colour mixing; the substances which can be used to make pigments and dyes; the use of colour in the history of art; and finally a potted biography of colour theorists. Each of these topics within the domain can be investigated and understood in isolation from the others, but developing knowledge of more than one theme within the domain can contribute to a greater understanding of individual themes. Using a hypermedia network as the basis for the design provided a system where elements from all these areas could be linked together.

To represent this area of knowledge (knowledge domain) I found a map or intuitive model of the domain to be essential. Combining the areas of study by the means of a concept diagram was a useful way of mapping the structure and visualising how different areas might be linked together. The diagram of the

intuitive model (see Fig. 8) formed the basis for the design of the colour theory CAL “stack”. Each pocket or “node” of information is represented by keyword(s) in a box, and the links between these nodes are represented by lines or arrows.

An intuitive model of a knowledge domain gives a quick overview but does not necessarily provide a well-formed syntax. This is because the meaning of boxes often changes from one place to another and the precise relationships indicated by the arrows that connect the boxes are often not well specified (Macdonald-Ross, 1972). The arrows that connect nodes of information have particular importance since it is the relationship between ideas/nodes that is usually being represented. It is a combination of the content of ideas/nodes and the way that they connect together that makes knowledge coherent. In the concept diagram, taken from my design for a colour theory CAL package, the named links can be seen. Careful labelling of connecting arrows makes the intuitive model resemble more closely the collection of ideas it represents.

Designing to ensure that particular areas are not missed: constrained nets & loose hierarchies

In parts of the domain it is probable that most of the students know some things, but it is important to ensure that students encounter specific nodes on their way to goals. To facilitate this, I found it useful to apply MacDonald-Ross’ delineation of the “constrained net” or “loose hierarchy”, in which the known nodes (subject areas) are regarded as prerequisites and the unknown nodes as goals. There are other nodes that lie between these, and the student has a choice of routes through them on the way to the goals. If the re-entrant loops are cut from the goals, so that a user cannot backtrack or skirt around a node, what is left is a constrained

net/loose hierarchy. The colour mixing exercises included in the package design conform to a loosely hierarchical structure (see Fig. 9). This configuration of information allows the maximum range of routes between known and unknown nodes of knowledge, within the constraints that the prerequisites and goals impose.

When presented with a collection of information, such as a CAL database about colour theory, and a goal, in this case to understand more about colour, people take two distinct approaches to learning. Some will work towards their goal “holistically” and some will choose to work “serially”. It is important to take these different approaches to learning into consideration when designing the stack, in order to ensure that learners can approach the computer representation of the knowledge domain in whichever way they prefer.

Serial learners and holist learners

Students work towards goals in two different ways. Some build up to their goal step by step, aiming at just the node that they are currently working on. These students are known as “serial learners.” The others prefer to work on several nodes at once, or jump back and forth between subjects, while having a goal in the distance. These are the “holist learners.” Both types of student will work well according to their own study style, but if they have to work within the opposing strategy their performance drops considerably. Serialist learners made to learn in a holist manner perform poorly and vice versa. Providing users with access to the overview of the stack of information at any time allows serial learners to trace a route through the stack, while equally allowing holist learners to perceive the ease with which they can jump from one area of study to another. Providing access to

the overview, or map, of the stack and adding a function which allows users to “jump” straight to any of the nodes displayed allows serial learners to follow routes while holist learners can enter and leave areas at will.

Macintosh knowledge domain authoring packages

HyperCard™ and SuperCard™ are authoring packages which operate on Apple Macintosh computers and facilitate the design of interactive databases. Simple functions built into these programmes enable a designer to build up a number of different nodes of information and make links between them.

The user/student can flick from one node to another (nodes correspond to what are called “cards” in HyperCard™) by activating appropriate boxes (called “buttons”) which appear on the computer screen. These are activated by moving the mouse so that the cursor is within the “button” area and clicking once. The author primes these buttons to take the user to a certain card or series of cards when a button is clicked; these cards can contain text, colour graphics and animation sequences. Buttons can also trigger sequences of video which either play on a separate video monitor or on the computer screen, and can activate sounds stored within the program.

The collection of cards is known as a “stack” and the construction of the stack is dependent on the links between the cards. The links are programmed into the stack by the author and these correspond to the arrows on the intuitive model/overview. The cards correspond to the nodes on this model (see Fig 8). A card can contain texts and graphic images, the buttons can be graphic icons or words. Buttons activate links which cause other cards to be displayed on the

screen or play a stored sequence of video, an animation or a sound. Links can also be made to other stacks/knowledge domains.

From drawn knowledge domain to computer stack

A hypertext or hypermedia computer system can be used to transpose knowledge domains to a computer and facilitates the design of routes through the domains. The relational net structure of the colour-in-art-and-design knowledge domain is easily accommodated by SuperCard™, a program created to run on Apple Macintosh™ computers. This package enables the author to create an elaborate network of pieces of information, using colour graphics, text, animation sequences and sound. Video images stored on tape or disc can form other nodes that can be linked up to play on the same computer screen when activated.

SuperCard™ allows nodes of information to be networked together in defined clusters, with limited freedom to travel through this network. The student can browse through some sections and focus in detail upon others, depending on particular interests. Areas can be left out by the user without harm and the user can search quickly for information of specific interest. The user/student has the option to search for any topic, or key figure, by typing it in using the added “search” function. This “search” function would be available at any time (see Fig. 10).

Using SuperCard™ for the teaching package it is possible to produce a design which gives the opportunity for students to begin either with examples of artifacts, and from there to go to the theories that they illustrate, or vice versa, for example an image of a Seurat painting can be the focus for an exploration of

colour mixing and a study of the work of the chemist, Chevreul. Alternatively, the Seurat painting may be referred to during an exploration of the function of the eye (see Fig. 11). It is possible to offer a choice of video guides to take the student on a variety of routes through the knowledge domain. These guides can be designed so that each have particular interests which are reflected in the route that they take through the knowledge domain/stack. The idea for using guides has been adopted from the BBC research into multi-media encapsulated in the project Future Worlds. Future Worlds uses guides like Richard Attenborough and biologists who offer different views about the subject of wild gorillas.

Users evaluating their progress

Using hypermedia learning environments it is possible to include structures which enable students to evaluate their understanding of the knowledge domain. This evaluation can take the form either of a feed-forward hierarchical system (with successful completion of some type of test becoming a prerequisite for continuation through the domain) or it can be a reviewing procedure, which may suggest further study of a given area but not make it a prerequisite for movement in a different direction. At key points the user can be given the option of doing a brief test to ascertain how much of the previous area they have understood.

Adding information: annotation permission

Using SuperCard™ to present this knowledge domain does not offer total freedom to the user. The computer program allows the designer to form links between graphics, text and video nodes that are not necessarily seen on screen simultaneously. The connecting points that facilitate a “jump” from one node to

another are defined by the designer rather than the users/students who use the resulting package. Although a student can add links and nodes of information s/he cannot remove the initial core information and links. Annotation permission allows the students to enlarge the data bank, and therefore not be entirely dependent on information collected by the author who, no matter how studious, cannot be expected to make all the connections that are possible and include every possible relevant piece of information .

In this way the stack design is like a Humanities Curriculum Project starter pack. These packs provide a variety of texts and images related to their subject (family, religion, war etc) but are designed to encourage teachers and pupils to gather their own information and add them to the packs. The packs therefore develop into a larger and larger collection of material such as photos, stories, taped interviews and newspaper cuttings, which it is hoped show a number of different points of view on a range of interests and issues. By encouraging pupils to add their own research the aim is to promote discussion. The emphasis on adding to the starter packs also develops learner autonomy, as the direction of project work is influenced by the particular materials students bring.

Using computers to produce interactive databases, such as the one outlined for colour in art and design, seems to be full of potential, and ultimately to be positive for education. Further consideration of the context within which CAL systems have been developed, and an outline of some of the pedagogies which have informed their production has been given in the chapter, *The Iconography of Knowledge Domains*.

Working with the colour signals in the material of video.

Producing layers of images is one approach to exploring how things are understood and the kinds of associations that an artist makes between images. Colour theory and the way that colour signal is composed is of particular importance to some of the techniques that I have used to combine video images as it facilitates the layering of different video recordings.

Layers of meaning and layers of images.

“The previously disreputable allegorical form has become of increasing interest to artists in recent years. As modernism (and formalism) are being challenged by postmodernist criticism and theory the unity of metaphor has been replaced by allegory’s density and layering of meaning. Fragmentation, transience, appropriation, deferral of meaning, impermanence and collapsed temporal dimension are some of the characteristics of the allegorical mode, as evidenced in the visual arts...”

Tucker in foreword to Wallis (1987) p.vii

Layers of meaning and connections (both conscious and associative) shape the form of my image making. Images develop from fragments of memories, in response to gestures that have unexplained resonance, for instance the dropping of pebbles into water or the sign of footprints. As a small child I was often taken to the local park, near Birmingham, by my mother. Here we would drop pebbles into the pond to watch the ripples disturb our reflections, and make patterns with our footsteps in the mud of the Lickey hills. These are the kinds of gestural memories that I find creeping into my image-making. New video and computer technology has given me the opportunity to layer these gestures and other images together on one screen. In Sequitur I used the technique of chromakey to build up complex combinations of images, fragmenting them, combining them and deferring their meaning through this process of montage.

The technique of chromakey: a description

The most frequent use of chromakey that most of us take for granted is its role in the newsroom. We are used to seeing the weather report with the reporter standing in front of a map and pointing out the forecast. In fact s/he is standing in front of a blue screen and the image of the maps are stored on videotapes that were played through this colour. This enables animated maps of changing weather patterns to be displayed clearly. More recently entire newsroom sets have been produced in this way. The distinctive cut-glass logo for ITN is actually computer generated and combined with a studio set using colour matting devices.

The chromakey process is the result of two video signals being fed into a chromakey unit and combined. These signals are taken from pre-recorded videotape or from a camera source. In the case of my work at least one of these signals is live, but this is not so for other situations (for example the special effects in films depend on two or more image sequences being combined after recording). The signals are electronically matted together. The process of this type of matting is to replace the red, green or blue colour signal from one source with a video signal from another source.

In the case of the weather report (where the signal of the reporter is live) the images from source 1 (which is the recording on videotape of the weather maps) are keyed through the blue signal on source 2 (this source is the camera which is pointed at the reporter standing in front of the blue screen). It is important that there is no blue in the elements of the source 2 other than the blue area designated for replacement by source 1 (the reporter does not wear, for example, a blue shirt

because if s/he did the map image would appear through the shirt). Blue is usually chosen instead of the green or red signal. If red were used the image would key through the red in fleshtones. In Sequitur cupped hands had blue dye dropped into them and images of the sea from a prerecorded source were keyed through this blue area as it gradually built up to the necessary density of blue colour (see Fig. 12).

Vision mixing and chromakey techniques were used to build up layers of images in response to my wish to produce layers of meanings. By using these techniques I aimed to match technique to visual theme, the material to the idea. One example is the sequence in which images of the sea were revealed in cupped hands, this alluded to the act of scrying (seeing the future by gazing at reflections on water). Technically, as blue dye was dropped into the water another image was chromakeyed through the blue area.

Prerecorded source tapes used in chromakeying were sometimes edited beforehand to enable further layering of images. In the shot illustrated in Fig. 13 the edit suite and vision mixer were used to overlay the fire background from one tape onto the eye which was recorded on a second tape. These two images were mixed together and recorded onto a third tape. This tape was then chromakeyed through the blue signal when shooting a circle of pebbles lying on a blue background.

Digital post-production techniques have now made it possible to combine numerous pre-recorded sequences using digital “matting”. With this technique sequences can be transferred from videotape to computer-disk and then combined to build up complex scenes. The 1992 advert for Ariston uses this technique. In it

actions by individual characters are recorded separately and then digitally matted together. The result is a medley of characters moving through space cyclically, their actions taking them close to each other. If this was performed with all the actions simultaneously it would be impossible for the characters not to bump into one another. Digitally combining the images suspends our disbelief. This advert is an homage to Zbigniew Rubzinski who was renowned for the complex film matting he produced. He hand painted exposed film with emulsion to enable him to re-expose it with another action and hence build up complex scenes of different actions. Mimicking this digitally it is possible to produce images with greater accuracy and speed than film matting and to avoid the image degeneration associated with video chromakey. Analogue chromakey (which is the technique I used in the video Sequitur) results in a loss of image quality with each re-recording of a sequence.

The studio tests

Using chromakey techniques seemed one solution to a dilemma I had when I first began to produce art pieces with video images. In my previous experience of installation work, more than one component and image could be displayed and experienced by the audience simultaneously. When working with single video tape projects this was more difficult. As an artist who enjoyed working with the surface texture of objects which I built my self, I found it hard to represent my ideas with the “one-image-at-a-time” style which I associated with much video work. Matting images together was one of my goals but to do this digitally depended on expensive equipment which was out of my reach. The chromakey kit which was available to me was quite old and under-used, so I could experiment with it without competing with lots of other people for access. I did

not want to combine images in the way that results in the weather report, or the way that Superman is made to “fly” over cities.

Instead I wanted irregular areas of images to be combined and I wanted the process of combining the image to allude to the ideas of the project. The structure of the keying could be visible (rather than rendered invisible, like the weather maps which are presented as a picture on a newsroom wall). Looking through my storyboards, I recognised that water and reflections were a recurring theme, but I could not recall having seen anything which utilised keying through water, so I decided to experiment for myself. This presented me with the challenge of keying through a substance which was not fixed but fluid, and prone to movement. To see water while containing and controlling it, depends on the container being transparent, and this is where my problems began. Lighting glass to avoid reflections off its surface is very difficult, in Sequitur I used a glass tube as the divider of the monitor screen and as the vessel into which a hand poured sand, alluding to hourglasses and the passing of time. This was very hard to light, behind the tube I positioned blue card to present an area of colour through which the image of a growing seedling would be keyed. The idea of this sequence, or sentence, in the narrative of the image was to have the sand (time) filling up the tube and gradually obliterating the seedling (once the sand obscured the blue background of the tube the seedling image had no blue area to be displayed through).

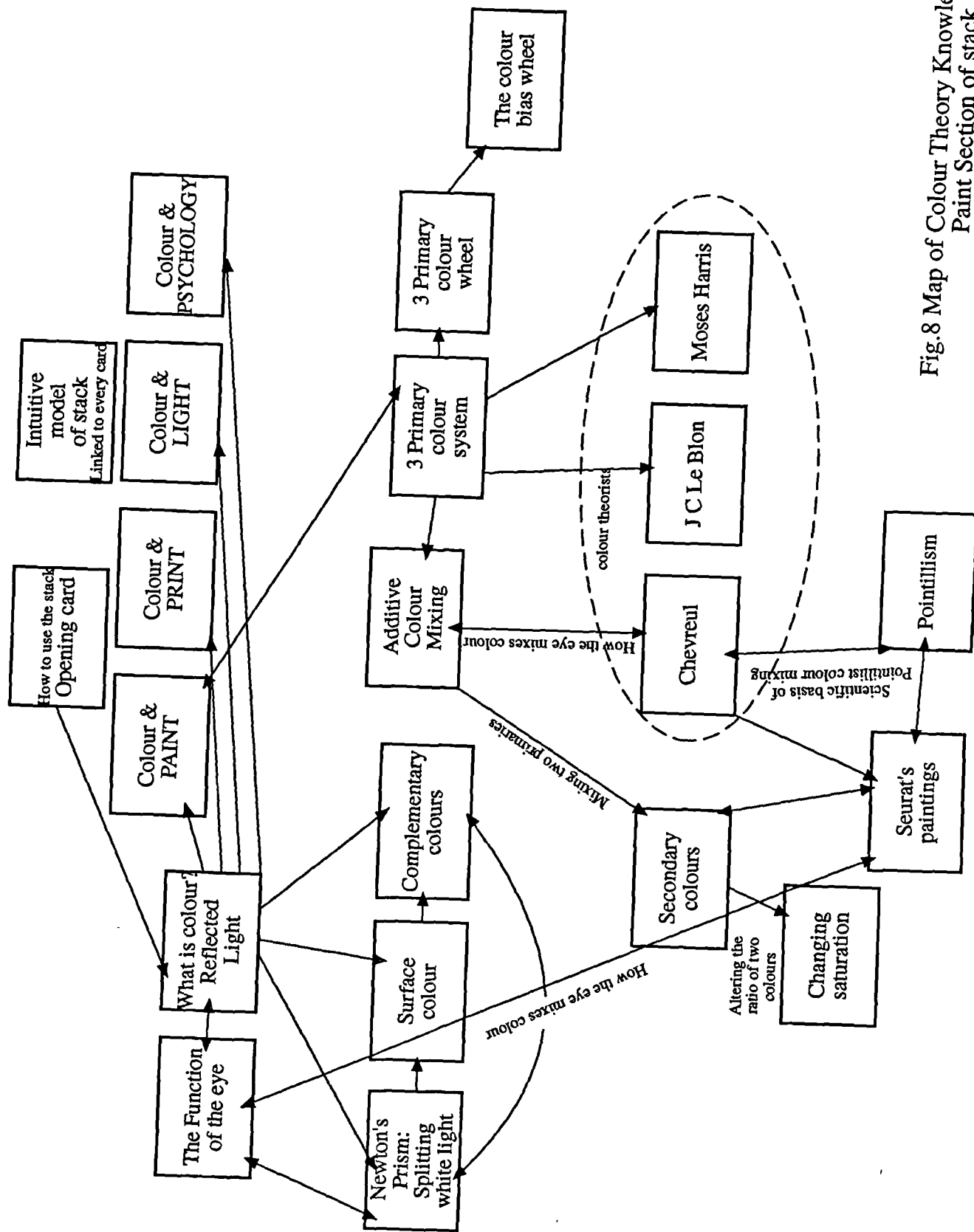


Fig.8 Map of Colour Theory Knowledge Domain.
Paint Section of stack.

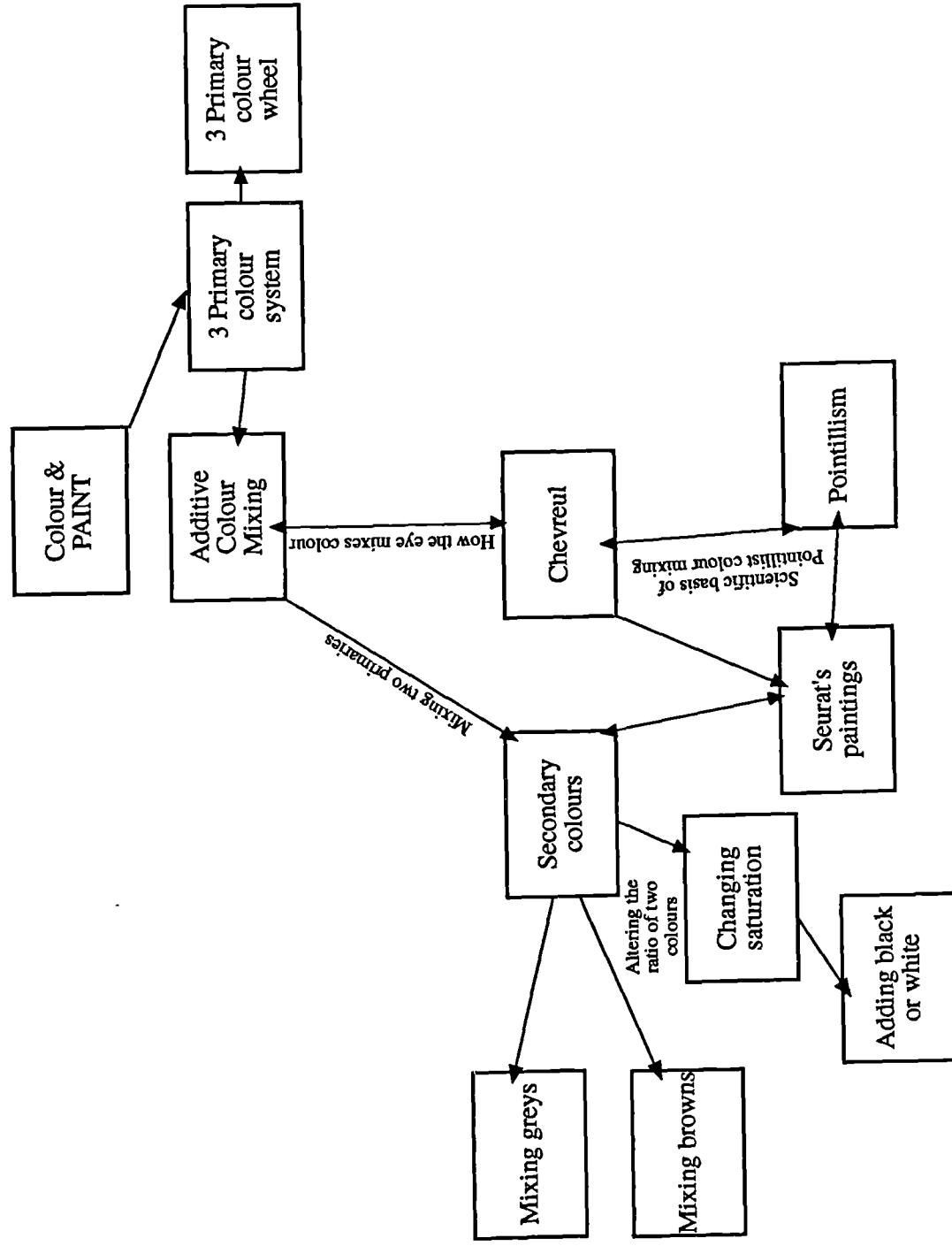


Fig.9 Map of Colour Mixing Hierarchy.
Paint Section of stack.



Fig 10: The SEARCH function. By clicking on this button (which is always available) a user can type in a subject and the cards can be searched and corresponding contents listed. Any cards found can be accessed immediately from the search list which is displayed.

THE FUNCTION OF THE EYE

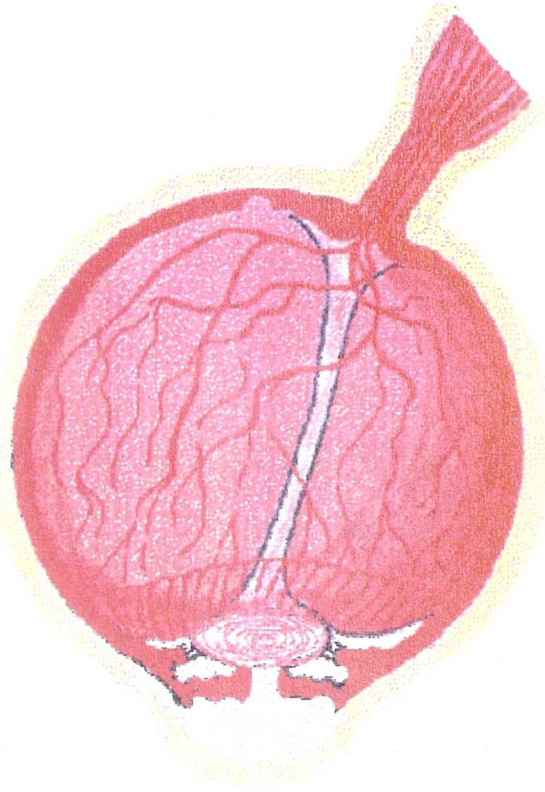


Fig 11: Click on the button marked **CHEVREUL** will open a card which describes his colour theory in relation to the functioning of the eye. Clicking on **SEURAT** will open an image of LA GRANDE JATTE, which in turn has close up buttons and comments on the way that the eye mixes colour when it looks at Pointillist painting.

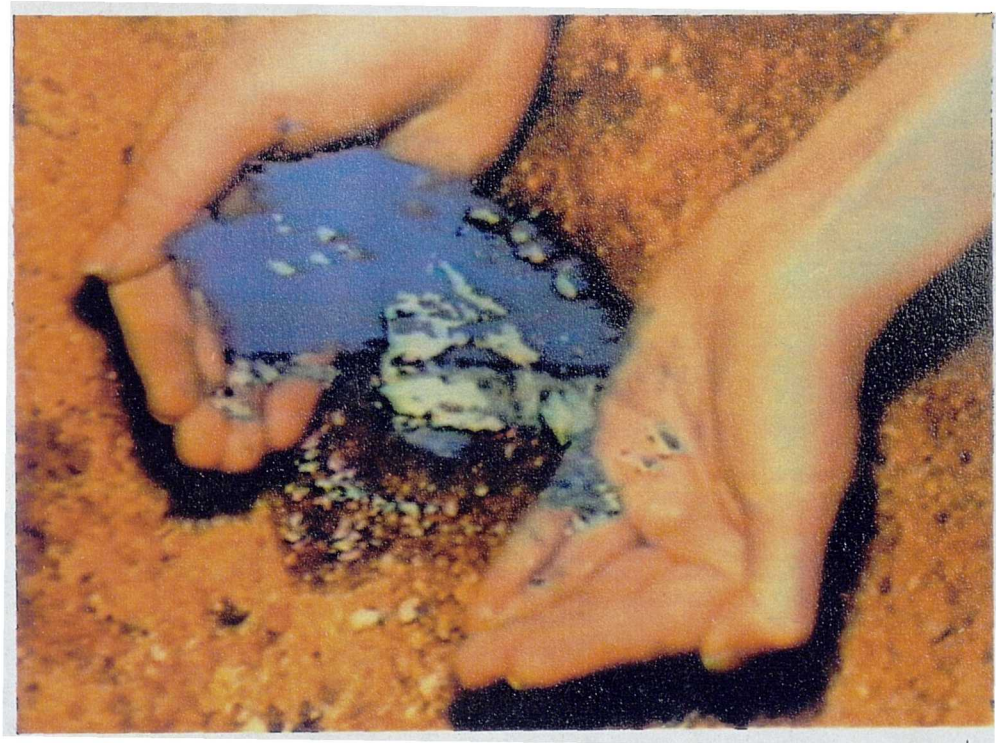


Fig 12: Stills from Sequitur, by Jane Prophet, 1989.
Showing cupped hands holding water into which blue dye is dropped.
Through the emerging blue colour a video sequence of the sea is chromakeyed.

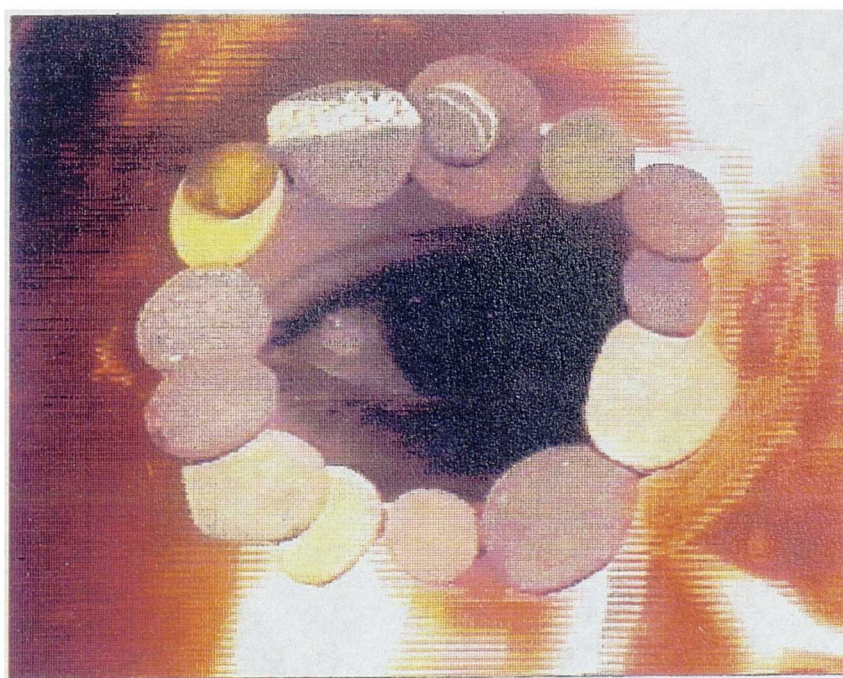


Fig 13: Stills from Sequitur, by Jane Prophet, 1989.

Top: Two pre-recorded images combined using a vision mixer.

Bottom: The composite image (shown Top) is chromakeyed through a blue background, on which a circle of pebbles has been placed.

ELECTRONIC MEDIA AT A CULTURAL CROSSROADS

The journey to the crossroads.

The versatility of computer equipment and its proliferation has resulted in significant additions to the processes of image production. Electronic media have brought us to a cultural crossroads. At this crossroads users of similar technologies are converging from many different directions. There is a “lateral” (Pickover, 1990) use of the same software in fields as different as art, computer-science, education, medicine, journalism, defence, hacking, biology, mathematics for visualising. Before the crossroads itself is explored, I shall map out the surrounding area.

In the fields of science and mathematics computer imaging is used to reveal hidden relationships and simulate nature. In medicine computers are used to describe the magnetic fields emanating from the brain and heart. Chemistry, physics and biology utilise computer visualisations of structures like DNA and viruses. Industrial design, engineering and architecture use computers to model three-dimensional objects. Meteorologists use computers to model complex weather formations.

The art-science split

The split between art and science has not always been evident. Cave paintings were works of art dependent on a scientific understanding of the then current technologies of pigments and mixing. For a long time art was the dominant tool of communication and the chemistry used by fresco painters to explain key religious events pictorially, and artists were at the fore of technological knowledge of the age. Since the fifteenth century artists have been interested in,

and become experts at, using technologies and optical aids such as the telescope, and mechanical drawing systems like perspective. It should not be a surprise therefore to find contemporary artists using new technologies like computers in their artwork.

Until the twentieth century, people of learning (usually economically powerful men) were able to become equally conversant with all fields of science and art. In part this was because there was simply less to know, so a person could get close to mastering all that there was to know. As a result areas which we now consider as disparate, such as the arts and the sciences, were studied simultaneously. The rapid expansion of knowledge, the multiplication of discoveries in science and the acceleration of technological development has made it quite impossible today for one person to cultivate expert knowledge across a full range of subjects. Indeed, the terms are considered mutually exclusive by conventional usage. The culture has responded by normalising intellectual division of labour, and encouraging the acquisition of specialist knowledge in at most one or two areas. Many people now feel that it is better to be an expert in one field rather than be moderately knowledgeable in many (the big-fish-in-a-small-pond syndrome). This cult of specialisation has driven art and science away from each other not only in their substantive interest, but also in terms of how they are presented.

While the separation of art and science still exists it is gradually being eroded. As scientists have made discoveries that alter their perception of the world, artists have responded to these developments, reflecting and integrating them in their work. Tom Hudson in “Current Issues in Art and Design Education: Art, Science and Technology: Some Initiatives for Change” (1987) generalises this point, observing that artists took some time to respond to both Newtonian physics and

the revolution of colour theory. The colour theorist, Michel Chevreul, though a scientist, considered colour both in clinical and aesthetic terms and his work had a significant effect upon the Impressionist and Post-Impressionist painters.

Similarly it was the technological advances lying behind the invention of the automobile which inspired the Futurists. As new concepts and new technologies are evolving faster and are chronologically closer and closer together, one might anticipate a corresponding speeding up of artists' responses to them. The mechanistic Cartesian view of the world as an entity made up of numerous separate and distinct objects supported the separation of art from science and contributed to the way that the two are held to be very different and easily distinguished commodities. In contrast, Einstein's synthesising theory of relativity and quantum theory imply a view of the world as harmonious and unified. Modern physicists are now describing the world in holistic, interconnected terms, seeing it as a mass of inseparable elements. In this world art and science are connected and the Cartesian view is left behind.

“Where the world ceases to be the stage for personal hopes and desires, where we, as free beings, behold it in wonder, to question and to contemplate, there we enter the realm of art and of science. If we trace out what we behold and experience through the language of logic, we are doing science; if we show it in forms whose interrelationships are not accessible to our conscious thought but are intuitively recognised as meaningful, we are doing art. Common to both is the devotion to something beyond the personal, removed from the arbitrary.”

Einstein cited in Peitgen and Richter (1986) p1

The differences in response between artists and scientists to new technology is epitomised in an incident involving Ronald Baeker's GENESYS system, built in 1969 at MIT, when the artist Lynn Smith used it to create cartoon characters. To a scientist the after-glow from the dots on the screen generated by GENESYS was a

fault to remedy and eliminate, but Smith saw it as a bonus and used it as a new effect in animation. The difference in the ways that the after-glow was interpreted goes some way towards illustrating Einstein's point - to the scientists it was a hiccup in the way of their goal, devaluing their work, while the artist had an intuitive response to it and felt that it had value and meaning.

The perceived separation of art and science plays an important part in the production of images by artists using computer technologies. Computers are associated with science, with number-crunching, with the realm of mathematics and statistics, with video games. The latter generate graphical interfaces which are sometimes considered to be a form of populist "low" art, similar in status to the comic-strip. Other computer graphic images are ruthlessly commercial, functioning as signifiers to other products rather than offering images for their own sake (see Fig. 14 where the polar bear clutches a bottle of Coca Cola, the ice-scape implying a drink that is cool and refreshing and the scene of the bears watching the Northern Lights intimating that Coca Cola drinkers are reflective, or that Coke lights up your life). The computer's ability to function as a storage system for text-based data which can be rapidly accessed has eclipsed its applications as an artistic medium. In many people's minds the computer has in consequence been reduced to a calculating machine, a mechanism for storing data and statistics. The way that computers are programmed to store images and text by translating them into collections of binary code is negatively interpreted as the depersonalisation of information, rather than likening this process to the reduction, for example, of the body for scientific descriptive purposes into a collection of atoms. The idea of transcribing the intuitive and spontaneous mark-making of an artist to a series of zeros and ones is abhorrent to many artists. It threatens notions of the unique act of creating images (for the zeros and ones can

be so easily reproduced) and it means that an image can be represented as a print out of numbers with no colour, no recognisable marks, and no planes.

Electronic media hybrids.

The use of information technology by what has become categorised as an “information society” is now widespread. Artists, scientists, defence workers, medics, writers, computer hackers, media moguls and cyberpunks use electronic media for visualisation. The points of connection between these people are increasing to the extent that they are in danger of forming a heterogenic group. The developing self-awareness of this community reflects the networking aspect of the computer that has become synonymous with our view of these machines.

With the boundaries between specialised areas dissolving, and the convergence of previously disparate groups there is a collision of contrasting aesthetic styles and their implicit ideologies. Jean Baudrillard in Simulations (1983) has theorised the changes in social structure that gives rise to the shift in position of the image. For him there is no longer a distance between the image (or text) and that which it refers to. Representations of reality have been replaced by simulation. This applies to simulations across the once diverse areas already outlined.

The scientific team vs the solitary artist

“brothers in a worldwide order where the individual ought to retreat behind the great common work”

Eilenberger (1986) p.175

Eilenberger describes scientists as working communally on a view of the

universe, their individual aspirations sublimated in favour of, or geared towards, creating new objective truths which can be proved, or at least generate hypotheses which are open to falsification. Such truths gain credence by their nature as concepts which can be demonstrated by people external to their discovery. The ability for others to interpret/prove them increases their perceived value. This is not a description that could easily be applied to western artists who are mostly engaged in individual practice which results in a personalised, subjective view of the universe, or more frequently a minute part of it. These views are rarely supposed to mean one clearly defined thing to all people. Moreover the meanings derived from art works are often closely linked to perceptions of the artist and critics which are themselves highly subjective and open to variation. Part of the pleasure of viewing and participating with art is the process of reading the work, the act of engaging with an image, object or space and trying to understand and interpret it. Comparing your own response to other peoples' is also part of the enjoyment, and this is not lessened if you discover that your response is very different to theirs. In science it is important to achieve the same results and come to similar conclusions.

But the notion of the art work as a product of an individual's unique endeavour is under assault. While using electronic media does not preclude individual work of this nature it does make it easier for artists to collaborate. The FAX machine enables written and drawn ideas to be generated through correspondence. The computer disk similarly enables images to be transported between artists. Recent developments have resulted in experiments at Nottingham University where researchers are sending moving image sequences from computers at Nottingham to computers in Southampton using the electronic mail and education JANET system.

The complexity of some art projects which are collated and generated on computers is such that artists are increasingly prompted to work in teams. These groups which may use the computer to combine video, photography, 3D animation, text and sound often function in ways similar to video and film production units, with members taking specialised roles. Like Eilenberger's scientists, many of these individuals share a passion for the "great common work" and work together on a collective idea with each individual contributing at all levels of production.

Psychedelia and cyberdelia

Timothy Leary's belief that computers are the new LSD implies some connection between psychedelia and cyberdelia. Although Leary himself has apparently discarded the drug culture on which his early reputation was based, he now shares with many ex-hippies from the sixties the New Age philosophy of clean living - no drugs, no junk food, green is clean. A look at the new technology counter culture shows that it is not just made up of clean-living Iron John men and New Age post-feminist women. The cyber underworld is a truly heterogenic community. The language of Mondo 2000, self-proclaimed mouthpiece of this underworld, is reminiscent of punk fanzines, computer magazines, war rooms and science fiction writing and reflects the jargons of its multiple sub-cultures. Cyberpunks, as the inhabitants of this subculture like to be known, share what the post-modern writers Deleuze and Guattari call *bulbs of language*. As previously noted, cyberpunks come in many guises; the rhizome of this subculture seems to be spreading along binary fluvials. Some of those people who make up the current group of experimenters with psychedelics and hallucinogens bear

testament to the frequent mix of computer imagery with the designer drug Ecstasy. In clubs across London, artists like Andrew Barklem create computer images and text to accompany the dance music and the Ecstasy. In Sheffield, Phil Wostenholm's images are similarly used, and combined with work by mixed media artist Nick Cope to produce film projections for live bands such as Cabaret Voltaire. Wostenholm catches the general flavour in the excerpt from an interview with the author:

"I think that the computer has been the first way that we've been able to externalise our internal visions, in that what we'd normally only be able to see in our brains, we can now visualise on the outside far quicker than we used to be able to. The original technology used in psychedelic culture was really low-tech, you could only use film projectors and oil wheels - pretty rudimentary technology really - which meant that the "realness" of the psychedelic vision was impaired. The fractal area is probably one of the closest to the workings of the brain, not just because it resembles the external world but because it resembles the internal. The actual structures of fractals are amazingly close to the structures of the psychedelic vision, images grow and change in the same kind of way. There are very complex shapes which usually include a lot of spirals and fern shapes that repeat infinitely. But I've never seen anything that can duplicate the colours yet. Because of the nature of the brain and the way it's producing the images, it's a difficult thing to simulate because of the speed at which it calculates its images." (Interview transcript 1991)

If psychedelic drugs are the road which artists like Wostenholm travel to "get inside their heads", then increasingly the computer is the tool with which they choose to try and describe what they find there. For those people who have experienced altered visual perception as a result of taking LSD or other psychedelic drugs, the image of the Julia set supposedly bears a strong resemblance to the visions of the "trip". Heinrich Kluver's investigations into the form-constants of elementary images in psychedelic visions, Mescal and Mechanisms of Hallucinations (1966) found visual themes like the spiral, lattice, tunnel and cobweb common. These shapes are recurrent in Mandelbrot sets,

which are often characterised by their vivid colours. The psychologists Grinspoon and Bakalar (1979) emphasise that after taking hallucinogens like LSD

“colours seem dazzlingly bright and intense ...Everything may seem bathed in light or illuminated from within.” p.94

The fact that these images are often viewed on computer screens is also significant; the dazzling colours of the Mandelbrot do seem to be “illuminated from within” because the screen is literally light-emitting.

From the cluster of groups which have congregated around electronic visualising technologies, there have emerged areas of commonality. This may in part be a result of the traffic between the areas, with exchanges leaving a residue which has contributed to a change in aesthetic. The following section explores some of these areas in more depth.

Saving, retrieval, plagiarism and artistic identity

Saving and retrieval

One of the distinctive characteristics of the computer is its ability to save, and later retrieve, different versions of a single piece of work. One view of these attributes is that they inspire a lack of respect for digital imagery, largely because they render useless the aesthetic monad of the single and unique version of an art object. This is countered by those who interpret this characteristic as an invaluable means of trying out combinations of colour, movement and texture, quickly producing many variations of a motif or theme. As well as making experimentation easy, the computer’s saving and retrieval function also makes

cross-fertilisation between images simpler. As Phil Wostenholm puts it:

“I’ve used a lot of images that I considered a finished image as building blocks to make a new set of images from. It’s an infinite process of creation and destruction constantly. I’ve never really considered any image completely finished.”
(Transcript of interview 1991)

A theme common to much contemporary artwork is the rapid changes which occur in our living environment, a theme which dominated the Cubists’ and Futurists’ work, which presented and celebrated the world as non-static. The computer’s ability to save and retrieve images at various stages of development can be seen as a reflection of this. It also means that the image presented as the “final” image may be one that was produced early on in the creative process, later changes may be discarded. This ability to select from a series of pieces is not restricted to computer imagery. Photography, video and film-making are open to this type of rearranging-in-time. A photographer can work on a print in the darkroom in many different ways, keeping versions as s/he goes along. Similarly videomakers can edit images in various orders with different visual effects, different soundtracks and with the addition or subtraction of text and graphics. The last version produced chronologically may not be the one presented as the “final” version.

“Plagiarism”, “sampling” or “selecting uniquely”?

As the sub-heading above illustrates, we do not as yet have the vocabulary to describe this technological borrowing without imbuing it with a powerful emotive edge. “Plagiarism” carries with it a negative connotations, though writers like Acker and Burroughs have sought to give it wider, and more honourable meaning than merely the theft of “original” work, by seeing it as both homage and

extension. “Sampling” has an air of the distanced and abstractly mathematical, and thereby perhaps risking the inference that it is aesthetically valueless. Yet both these terms are steeped in an aesthetic tradition which art made with computer technology seems bound to break with. Even the term “selecting uniquely” to describe the frame-grabbing of images and text has an authority based on our reverence of the unique in art:

“Even the most sophisticated sample (of image or sound by computer) is only an approximation (abstraction) ...The resolution of the sample depends upon the computer. The artist has gained control in exchange for simplification.”

Walters, Hodges and Simmons (1988) p.102

The word “sample” implies random representativeness rather than the selection of an imaginative growth point, and the pillaging of images does not, at first blush, appear likely to underpin creative activity. This notion that the visual world is merely an image library open to plunder by maniacally frame-grabbing digital artists appears by conventional standards as unattractive, and has led to the denigration of computers as creative tools for artists. Richard Wright abhors the “high degree of violence” that can be perpetrated on a “captured” image by using functions such as “stretch”, “distort” and “squash”, noting that it would be culturally incongruous to slice up an original Van Gogh in order to experiment with collage. He depicts the image within the computer as “down-graded to visual fodder”, thereby rendering the original less significant. Yet this dismissal of computers as tools for artists is only possible because Wright is trapped in the assumptions of the old aesthetics.

The pillaging of images can also cause offence, as Sally Thomas found out in 1992 when a photograph in her “Baby Doll” series came to the attention of the well-known woman photographer from whose work she had scanned in a key

component who recognised the theft at the Camerawork exhibition of third year work. Rather than hack out a defence of the ideological principle, Sally collapsed in tears before her accuser.

Surely the visual world is no more an image library for digital artists than for artists of any other kind. Photography, film and video also provide means for grabbing frames from the world, and are equally open to distortion via the use of fish-eye lenses and distorting mirrors to name but two. Like the computer, the camera was initially regarded by art critics as inferior to traditional image-making tools. Francis Bacon could equally be said to perpetuate, “a high degree of violence” and distortion upon his subjects, using merely a paintbrush (for example in his “Screaming Pope” series). Therefore it seems to me that it is not the distortion, nor the violence but rather the tool itself that critics such as Richard Wright must object to. Other forms of electronic artwork have processed images in ways which could be deemed disrespectful to their original semantic or formal quality. In videomaking, also, the reappropriation of images from film and television could be likened to the frame-grabbing of famous paintings. The video edit suite and visual effects unit have long been used to re-present these images in a distorted way, often with striking effect, thereby creating a new meaning. The notion of creative synthesis comes into play frequently in these instances (and is important to scientists as well as artists). The whole can be more than a sum of its parts: it can become a new entity.

Authors who extract passages from the work of others have experienced similar criticism to those artists who use visual or audio samples. Kathy Acker has, for example, been denigrated for appropriating text written by Harold Robbins and her book, The Adult Life of Toulouse-Lautrec was taken off the market as a result

because her publishers were afraid Robbins would sue (McCaffrey, 1991). Acker interprets plagiarism as presenting someone else's work as your own and prefers to use the term "appropriation" to describe her use of texts originating from other authors. She uses these in the creation of "de-narratives" (Wolf, 1991) via the deconstruction of found and original texts which began as an intuitive practice, and has become informed by post-modernist theory and the writings of authors like Deleuze and Guattari. Acker chooses "hot texts" - writings on sex or politics - and juxtaposes them with texts such as those she has written about her mother's suicide, finding that combining them as if they were the same text makes illuminating connections. Similarly artists like Maxine Hall take samples of images and juxtapose them to generate new meanings (see Fig. 15). In literary circles this process can be seen in the work of Norman Mailer, whose book Marilyn: A Biography distorts the truth towards a biographical myth, although one based on facts. He describes this as dealing with "factoids". This type of approach is also evident in the recent proliferation of programmes like Crimewatch UK, which use stand-ins to recreate crimes in the hope of jogging viewers' memories, a technique echoed in the plethora of films based on the stories of criminals such as Henry: Portrait of a Serial Killer which is "faction" built up from research into numerous killers to create an amalgam character and story.

The map of the crossroads

Given that there is a sizable overlap between the psychedelic and cyberpunk sub-cultures, the heralding of fractal images as "cyberdelic" is consistent and unsurprising. In considering the reasons for fractal images being so popular with the psychedelic subculture I feel that of equal importance to the similarities

between the appearance of fractal images and the visions induced by psychedelic drugs is the theory that lies behind their construction. In the recordings of psychedelic experiences (Grinspoon and Bakalar, 1979 and Aaronson and Osmond, 1971) there are many references to both the drug users' interest in exploring visual detail, and their feelings that everything in the world is connected, that even something which seems chaotic is actually conforming to an order that was hidden to the user before they took the psychedelic drug. The iterative patterns of fractal images support these psychedelic visions, since fractals virtually demand detailed inspection which reveals yet more detail. The fashionable arrival of chaos theory (Gleick, 1987) has proved attractive in offering a vision of the hidden order behind seemingly chaotic and random events.

Just as there has been a change in physics in favour of seeing the world as a collection of infinitely connected parts, so there is a need within art practice and education to recognise the points at which art connects with other disciplines. New technologies provide us with the tools to continue experimenting with making connections; computers enable us to program interactive environments which connect the participating "audience" closely with the work and with each other. Using these applications would seem a timely response by artists to a shift towards integration and connectedness on a global scale.

At the same time, the dominant scientific aesthetic which sees images as visual representations of numerical data, or as "proof" that an algorithm works, is gradually changing. Scientific theories, such as chaos theory, are now able to describe hitherto inexplicable "chance" events, and to offer explanations which challenge creation myths (recent acceleration of confidence in the "big bang"

theory). These areas are historically considered to be subjects for poetic and artistic musing, scarcely appropriate for the reverie of scientists. Simultaneously, artists are becoming literate in the use of computers, those number-crunching machines previously thought unworthy of their consideration, or alternatively beyond their competence.

In medical research, teams comprising of biochemists, programmers and artists are working to produce more appropriate simulations of organisms. These images are made into training aids that run on CDs.

The image is floating somewhere behind the physical surface of the computer's screen. Behind the image lies the matrix, dense with data.

Video

Video was developed as telecommunications and surveillance technology with military input. Its progress was backed by a TV industry anxious to control the potential waywardness of live broadcasting. The moguls' anxieties had been fuelled by events such as the rock group The Doors' rendition of the song "Light My Fire". The producers of the live show featuring the band had made it a condition that the lyrics would be censored and the band complied with this during rehearsal. But when it came to the live broadcast they reverted to the uncensored lyrics. The song went out on air because by the time the producers had realised what had happened it was already too late to control. Video tape recorders eliminate this risk as programmes are typically pre-recorded.

Early practitioners of video art seem, in retrospect, to have had a naive belief in

technological determinism. They used phrases like “guerrilla TV”, “democratic media”, and “the people’s tube” when describing video technology. They believed that by its very nature video technology would democratise and decentralise media production. Modernist video art was markedly political in contrast to the largely apolitical stance of Modernist painting. High Modernist painting was a reaction against the history of Fine Art painting, but High Modernist video art was a reaction against non-Fine Art visual practice - broadcast TV. Such video art reacted against television’s promulgation of conservative values and its ceaseless production of reassuring and assuring illusory representations of the social, political and cultural world onto which it claimed to be a window (Marshall, 1990).

The opposition to TV was shared by women video makers, but many feminists also saw their video practice as oppositional to the focus on the material of video, concentrating instead on using it as a tool of representation. This mirrors the basis on which some feminists questioned the values and concerns of formalist abstract painting, as illustrated in the following manifesto which accompanied the 1973 exhibition Womanpower at the Swiss Cottage Library, London:

“We regret the abstract researches, playful gimmicks characteristic of contented and successful male artists. Although aware that these are not entirely without purpose and interest, we feel that it is not possible as members of an oppressed group - half the human race - and with a powerful means of communication in our hands to sit around playing games with surface reality.”

Sjoo (1973) cited in Parker and Pollock (1987) p. 5

Sjoo proposed figurative painting as a more appropriate project for the feminist painter. In video and performance art women were similarly engaging in figurative studies rather than the formalist abstraction characteristic of artists like

Nam June Paik. But this move away from abstraction and towards political statement (in the case of women often by using the body as a metaphor) owes much to television.

In the 1970's and early 1980's modern abstract painting liberated the signifiers from the signified. Video artists similarly focussed on the inherent properties of the medium and the way it produced images. Paik imposed magnetic fields on the monitor to distort images, intervening with the electronic signal which is the material of video. By returning to the material of video itself, artists attempted to develop a grammar of video that was its own, which was somehow true to the medium rather than aping the language of film or the journalistic conventions of broadcast TV. These concerns informed the early video art and are evident in the numerous pieces that included live monitoring and image feedback. Scratch video was characterised by pieces that were made up of short sequences copied from TV. These works frequently drew attention to the video image's lack of authenticity and celebrated the electronic medium's characteristic ability to repeat sequences over and over cheaply and with little degradation.

However some artists played down the fetishisation of video technology (which they saw as parallel to the fetishism of the authoritative art object, which was emblematic of the male-dominated museum system and its power and prestige). These artists insisted on the need for representation, often using the presence of technology as just another element within the meaning of a piece, rather than making the medium privileged.

Images of female nudity: the current debate

One particularly difficult and divisive question in the current feminist debate concerns images of female nudity and how they might be regarded. One problem is that there is a visual equivalent of the intentionist fallacy which in effect prevents artists from owning the images they produce or determining the cultural use to which they might be put. Also, as indicated earlier in the section on plagiarism and the digital pillaging of images, subsequent reincorporation might make statements and generate readings quite different from those attached to the original, as Jacqueline Onassis found out when a photograph of her naked appeared in *Hustler* for purely social satirical reasons.

Cross-gender observation, according to John Berger in Ways of Seeing (1972), has been structured culturally as a matter of men looking at women.

“...men act and women appear. Men look at women. Women watch themselves being looked at. This determines not only most relationships between men and women but also the relation of women to themselves.” p.47

There is a collision of discourses when women use video to make images of either themselves naked, or naked men: the lens has become a male signifier, the camera a phallic symbol thrust into non-western cultures to record colonisation, and to reflect the white male view. When women take control of the lens the dynamic of the male gaze towards the female subject is broken, and what takes its place is women's presentation of themselves. Berger also relates the gendered distribution of gaze as an interpersonal ploy to the way women relate to themselves and to each other. The attraction that making images of women has had for women artists is to some extent explained by a need to re-possess the act of looking at ourselves, although if sexual interest is taken as the key it would perhaps be wise to admit the possibility that lesbian art can be as exploitative as

hetero art.

Taking the naked male body as a subject removes some of the controversies surrounding portraying the female body but replaces these with a different set of practical constraints. Women may make images of the female body with intentions different from many male artists, but the power of the gaze is still entrenched in established ideas of gender and control. When women make images of the male body the devouring male gaze is reflected. Homo-erotic art may focus on the sexual male, but centralising homage allows the subject to maintain control. Women artists are not guaranteed to be so single-minded. The male may be shown tired, vulnerable, the penis may be small, limp or (extremely) castrated. These challenges to the established representations of the male body evoke fear, anger and controversy. Reactions to the exhibition Women's Images of Men at the ICA in 1980 typifies these responses, there was hostile media coverage:

“An aura of sensationalism, of penises for penises’ sake, undermines the savagery with which some of the exhibitors have entered the arena.”

Waldemar Januszczak, The Guardian, October 3rd 1980.

The apparent tendency of women to produce work which is about personalised views rather than to make statements about “society” as a whole was one of the differences perceived by videomakers attending a seminar at the Museum of Modern Art in Oxford (MOMA). At the 1990 seminar at MOMA a male video maker stated that while large scale exterior works about large scale issues were generally made by men, women worked on smaller projects which tended to be of a personalised nature. My initial response to this was highly defensive; I bristled at the stereotype of the woman as inward-facing, small-minded, narcissistic, the stay-at-home and man as the coloniser, the adventurer, the hunter. Mentally I

sought to construct a list of Big Works about Big Issues by Women.

Women have been relegated to the periphery of image making and almost entirely excluded from the process of making (rather than being the subject of) erotic and pornographic images. The terms “erotic” and “pornographic” have significant linguistic heritages. “Erotic” stems from the Greek male god of sexual love, Eros. By contrast “pornographic” stems from the words “porne” and “graphos” meaning writing about whores (specifically and exclusively the lowest class of whore, the brothel slut who was available to all male citizens and was the only prostitute in Ancient Greece considered vile). It has only been recently that women have had the power and opportunity to address this, and both within and outside the women’s movement there has been a struggle with the discourse of feminism and eroticism which has pulled women in different ways. For example there are women who believe that images of female nudity should only be made and viewed by women. Within this group there are those who believe that women who make images which have any sadistic or masochistic “reading” should be censored. At the other end of the erotica and pornography debate in the feminist movement are those who do not believe in censorship of any kind. The current support of pornography offered by so-called “queer sex” is illustrative of the reaction against censorship by both government and “alternative” groups.

If, as Berger says, the act of looking is one that men do to women, and women do not do to men, then it is not surprising that using lens-based media to record the female form raises issues of “the gaze” to potent levels. Although there is wide agreement among women that men look at them, uncomfortable and widely divergent views have appeared concerning how this is to be interpreted. At its extreme, groups like Women Against Pornography (WAP), (see Dworkin 1981),

seem to believe that patriarchal society is sexually coercive towards women and that mental undressing, violence and rape are last resort “natural” outcomes. According to this view all images of naked women are pornographic in the hands of the male imagination, and are incitements to rape. For a time this position appeared to be endanger of becoming the feminist orthodoxy. Women of the Left were aware of fellow-travelling with the pro-censorship lobby but comforted themselves with the thought that principle makes strange bedfellows. As a woman video artist with an interest in representations of the female form, this is not my current position although I would have given unqualified assent to these propositions five years ago. In analysing electronic media at a cultural cross-roads the alternative paths need to be signposted.

Recent discussion of this issue in cultural studies has tended to concentrate on several seminal texts. One of the first feminists definitively to break rank was Susan Sontag (1982). As Andrew Ross puts it, what Sontag calls the “pornographic imagination” is clearly “a version of radical chic pleasure”, based on certain assumptions about avant garde elite taste and “bravely testing and exploring the transgression of social limits by libertines”. Yet not dissimilar images he sees as less “far removed from the semen stained squalor of the peep show, the strip joint, the video arcade and other sites of popular pornotopian fantasy” (see Andrew Ross, “The Popularity of Pornography” in Simon During ed, The Cultural Studies Reader 1993). Equally influential has been Laura Kipnis’s chapter “(Male) Desire and (Female) Disgust: Reading Hustler” in Cultural Studies (eds Grossberg, Nelson and Treichler 1992). She depicts the temporary hegemony of the feminist anti-porn movement as under threat from a number of alternative positions, including “pro-sex” S/M lesbians resisting the definition of their activity as deviant. These ideological writhings apart, the main

interest in Ms Kipnis account is her brave tackling of the debate via an in depth cultural analysis of the “undeniable grossness” of the American porn magazine Hustler. Since Hustler from its inception “made it its mission to disturb and unsettle its readers”, Kipnis might have been tempted to regard it as worthily “posing through the strategy of transgression, an interesting metadiscursive question: which are the subjects that are taboo ones even for sick humour?” Within the limits of acceptability as defined by Hustler she found jokes on Betty Ford’s mastectomy, dismembered Challenger astronauts, amputees and paraplegics. In sexual matters too, the Hustler body is gross and corporeal, the proper object of the disgust that Kipnis found herself experiencing.

The aesthetic of Hustler, and its intentions, appears to be radically different to that of many women artists working on the production of representations of the naked female form, including my own work. Although outside of our control, the audience and the viewing context may be the critical point of divergence between the images produced by Hustler and those produced by S/M lesbians or disabled women for different ideological and documentary purposes (eg the thalidomide woman, “unwrapped” in FAN magazine). The genres, however, can overlap, sometimes confusingly as in the work of Annie Sprinkle the ex-porn star turned video art producer whose 101 Ways to be a Sex Goddess remains an ambivalent piece, even after the discussion it generated at The World Wide Video Festival in, Holland 1992. In short “a feminist position”, self-proclaimed, may find itself anywhere between the essentialist-biologist Dworkin; Sprinkle and the wickedly titled On Our Backs team (a variation, as Teresa de Lauretis (1992) points out, on the feminist canonical text Off Our Backs).

I see my own work as a variation of Sontag’s elitist porn, praiseworthy for its

transgression of social limits but trying to avoid both mundane libidinal grossness and the decadent upperclass libertinage of Sade. In Roland Barthes' terms it will at best be a matter of *jouissance* rather than *plaisir* (see Mythologies 1972). I will return to my own video work in a later chapter and in the *Conclusion*.

**TECHNOLOGY-LED
CURRICULUM DEVELOPMENT AND
ART AND DESIGN EDUCATION**

This short interim chapter aims to provide a context against which subsequent chapters can better be understood. Following a brief history of technology-led curriculum in art and design education, it concludes with a cameo reporting on my own participant observation at Solihull College of Technology, giving a gendered account of the perceptions of students on the BTEC Media Course. Art and design education were to some extent latecomers in the curriculum reform movement, and not all of the standard generalisations about the problems and possibilities of curriculum reform can be applied without qualification. A sensible starting point would seem to be a quick summary of the history of curriculum reform in the United Kingdom, which will lead on to consideration of the complex interrelationships between technology and innovation in education which necessarily effects developments in both. This leads on to an analysis of the impact of electronic technology and the debate which it has precipitated in art and design education concerning the roles that computing and video might have in Further and Higher education, particularly art schools and universities or colleges with design studios.

In standard accounts (Stenhouse 1975), the curriculum reform movement itself began with a technological breakthrough when the Russians put up the first orbital satellite, Sputnik, following which the United States of America determined to make a massive investment in science education with the perceived purpose of closing the gap. There were hints around at the time that the problems of designing a science curriculum were not very different in principle from designing an orbital satellite, and means-ends rationality borrowed from Ralph Tyler (1949) became one of the key assumptions of curriculum reform, which tended to deploy “behavioural objectives”.

In the United Kingdom, curriculum development was much more ad hoc and pragmatic, and a series of first generation curriculum development projects was set up under the auspices of the Nuffield Foundation and the Schools Council. The spirit of the exercise was to allow schools and teachers considerable choice, and although nobody denied that the curriculum had now become a legitimate object of social policy, every Schools Council Working Paper included the disclaimer that the Council existed solely to “extend the range of choice available to teachers”. In practice this meant that almost without exception curriculum reform was being institutionalised through the recognition of growth points, sites where ideas-driven entrepreneurs (like Stenhouse himself) had persuaded others to back their ideas.

In many subject areas, including science, one of the main thrusts behind the curriculum reform movement in the United Kingdom was an attempt to discover the modes of inquiry that produce new knowledge in the subject and to move towards an inquiry-based pedagogy, inducting pupils at an appropriate level into the actual procedures of finding out. Nuffield Science itself had this dominant characteristic, and any technical questions concerned with apparatus etc. were considered secondary to this intellectual agenda. The Schools Council’s flirtation with technology as subject area or theme stood a little ambivalently in this overall agenda as its evaluator, David Tawney (1969), made clear. History, too, strove to introduce children to the interrogation of historical data. There were also a few interdisciplinary projects (the Humanities Curriculum Project, the York General Studies Project and the Integrated Humanities Project) but the contribution these made in general were to explore new maps of knowledge crossing discipline boundaries, and to facilitate social and cultural discussions in schools. Nevertheless, they are all relevant to the present argument in that they each

developed kits of resource material capable of being explored flexibly in theme-based teaching. In different ways they each sought to confront the problems of an adequate classification system for theme-specific multi-media kits. Although nobody was using the word at the time, thinking was moving in the direction of what we now call hypertext.

Standard histories of curriculum development (see Stenhouse 1975) indicate that the slide towards what Malcolm Skilbeck called “school-based curriculum development” occurred because of dissatisfaction with the “centre-peripheral” model. Rather than insisting that trial schools teach with unswerving faithfulness to the central prescriptions, it became seen as not only legitimate to adapt an innovation, but somehow rather a good idea. This movement was associated with a retreat from “quasi-experimentation” (see Campbell and Stanley 1963) in curriculum reform and an increasing view that programme evaluation should be formative rather than summative, a bit like military intelligence, managing the innovation in a way that recognised its organic quality rather than seeing it as a “treatment to be tested” akin to the manner of crop-yield studies in agricultural botany (see Parlett and Hamilton 1972 “Evaluation as Illumination” in Hamilton, D et al Beyond the Numbers Game 1977).

The collapse of the spirit of open choice in curriculum development occurred in the United Kingdom alongside determined government efforts to move towards a National Curriculum. This history has been explored in detail by Dennis Lawton in his The Politics of the School Curriculum (1980), but for the purposes of the present argument it is important to note that the government-initiated “programmes” that replaced the Schools Council/Nuffield curriculum projects and the Schools Curriculum Development Council (SCDC) residual local

initiatives often were given a strong technical face.

The first major programme with a strong technical focus was the National Development Programme in Computer Assisted Learning, directed by Richard Hooper (see Hooper 1977) and evaluated by the UNCAL team at the University of East Anglia (see for example the limited circulation Confidential UNCAL Evaluation Studies: CAL Project Information Exchange 1977). The National Development Programme in Computer Assisted Learning did not have at the moment of its initiation a strong coherent educational philosophy beyond determination to support and trial a variety of computer applications in selected institutions in all sectors of education, including FE and HE. Although individual sites developed their own agendas, there is no doubt overall that the initiative carried, potentially, all the problems of technology-led innovation. This is a theme I shall be returning to later, not least because this kind of hardware-driven policy opens up schools and colleges as a market for commercial firms hoping to sell products and applications.

Even more technology-led was the national Microelectronics in Education project, which lead inexorably to the government funding each Local Education Authority to set up one interactive workstation. As will become clear later, the technology is awkwardly poised between its potential to be neutral in the sense of not carrying strongly any particular curriculum prescription and the observable real-life constraints that it appears to do so, and is particularly perceived as carrying problems from a gender perspective, a matter returned to in the next chapter.

One relatively benign application has been the Doomsday Project, a database

holding details similar to that of the original Domesday Book, although its formidable expense meant that it could only be implemented to any significant extent through complex inter-school sharing. It could claim, however, to be exemplary in its fostering of inquiry-based learning with pupils actually participating in a recognisable style of historical inquiry.

It is probably also worth mentioning the more recent Technical, Vocational and Educational Initiative (TVEI), which exhibited some internal tensions between its vocationalism (always an issue in technological areas) and its en passant commitment to so-called “active learning” (see Jenkins, Batts, Davis 1985). TVEI dealt both with computer literacy as a part of general education and also with specific applications like word-processing and desk top publishing for the new generation of secretaries. Thanks to the substantial funding that TVEI received for its local and national evaluations, many of the issues which I have been exploring in relation to my own research in art and design education have been rendered clear in a parallel educational context.

Against this broad history, there have been corresponding shifts in what it means to adopt, adapt or implement an innovation. My interest in this issue is very context-specific in relation to my own work as an art and design lecturer in colleges and universities who has dealt with the technology both as a teacher in the area of computers and visual imaging and also as a video artist working at the outer edge of the technology. Nevertheless, some initial clarification is required in broader terms.

Innovative curriculum change in the context of new technology, particularly where it is technology-driven, has always been taken to imply training. This is

especially important when the technological invention has been developed outside education and teachers are initially unfamiliar with it. Also, technology-driven innovation is not legitimised or systematised in the usual way by bodies such as educational publishers, curriculum development agencies or organisations dedicated to in-service training. Some of the technology currently being implemented in mainstream education was originally developed for training rather than educational purposes. One clear early example was programmed learning, which tended to import with it non-liberal assumptions about the nature of the learning process. Although technology at best is theoretically neutral before alternative educational ideologies, at worst some technologies can be (and have been) deployed to serve manipulative ends. Several writers committed to a liberal ideological position have seen the lack of autonomy associated with “training” agendas in non-educational environments as generating a range of models and methods that are all-of-a-piece in proposing a kind of mechanisation of learning. Noble (1989), for example, cites

“...programmed instruction, instructional design, criterion-referenced testing, individualised instructional packages, the “systems” approach to educational administration, simulation software, skill taxonomies, behavioural objectives, the mastery learning model, and intelligent tutoring systems.” (p.17)

The Arts tended to miss out in the first generation curriculum reform movement with the exception of the Exeter-based Arts and the Adolescent Project (see Ross 1975) which shared home and hearth with Robert Witkin’s foundational exploration of a general model for creativity in education in The Intelligence of Feeling (1974). It was not until 1982 that the marginalisation of the Arts in school curriculum reform was addressed by an outside body, the Calouste Gulbenkian Foundation, which produced an influential report, The Arts in Schools:

Principles, Practice and Provision (1982, principal author Ken Robinson). Critics of government policy have held for some time that the so-called National Curriculum is having to contend with a back-to-basics movement ever ready to see subjects like art, drama and music walking the plank (a typical protest would be David Holbrook's TES article "Cutting Out the Frills; Cutting Out the Thrills").

In Further and Higher Education there has been a fluid period over the last two decades, beginning with the institutionalisation of broad Foundation Year Programmes in art colleges (Tom Hudson's at Cardiff being a seminal inspiration) and ending with the more recent moves towards modular courses and institutional mega-amalgamations. The technological base of art and design work has steadily widened, with CAD exercising more influence on design and computer imaging technology entering a whole variety of courses from textiles to media/cultural studies and media practice. All institutions are also trying to operate in a tougher political climate, and with both novel doctrines of accountability and the view that educational provision is a "product" that needs to be "marketed" (the fashionable word is "delivered") to the students-as-clients.

Colleges compete to recruit as many students as possible in order to maintain a sufficient funding quota, which is proportionate to the number of full time students (or their equivalents) that are registered and enrolled. The sheer numbers involved have greatly affected the staff to student ratio, which in turn has led to an increased pressure to follow mechanistic training strategies, to be sure not to over-teach and to replace/supplement academic staff with CAL devices. There has been an increase in the number of hours that courses designate as "personal" research for students which means a reduction in the amount of direct teaching,

and a corresponding decrease in the wages bill for the department. This has most frequently been achieved by reducing the allocated number of part-time teaching hours.

With the adoption of modularised degree courses, efficiency has become the dominant consideration when structuring media degree courses. The length of modules necessitates the allocation of the shortest possible training time, and there is an emphasis on short projects which serve almost as technical competency tests for the modules.

In the case of computers in arts education, these advantages might range from supporting better presentation of written work by students using word-processors, to making complex photo-montage images, printed in full colour from a printer, or producing advanced animations with relative cheapness. But rather than being advantageous over existing practice (i.e. replacing traditional methods) the computer facilitates faster processing of images for printing, and allows techniques learnt with traditional classes to be accelerated with the use of the computer as a prosthetic. Only in a few cases is it likely to replace an existing approach entirely (such as typesetting and page layout). The computer also makes it possible to bring together a mass of information (text, images, sounds) and make it easily accessible: it can substitute books and combine OHP, video and text in one unit.

In my own experience as a teacher using the new technology both in two FE colleges and a University, technological innovation in practice was implemented less radically than one would have expected because the new technology was frequently marketed with spurious appeals to the familiar. For example,

interviews with colleagues suggested to me that relatively naive users of the technology were more comfortable with it when it mimicked functions which are standard in pre-digital art production, as when programmes were able to replicate the smudging effect associated with a charcoal and pastel drawing technique. It was obvious that this simulated continuity in appearance provided a strong intuitive connection between the machine and long-established visual aesthetics, smoothing the way towards the adoption of the technology by non-digital artists. The reason for this commercial courtesy towards the consumer was that the alienating effects experienced by users of the earlier computer-imaging machines, which had produced distinctly regimented-looking images had by then become well documented. The aesthetic as opposed to the practical issues are dealt with in more detail in a later chapter, *Towards a New Aesthetic?*

One of the issues that I will deal with in the next chapter are feminist attempts to link some of these questions with what is taken to be the dehumanising rationality of an “androcentric epistemology” (see Marnier Lazreg “Women’s Experience and Feminist Epistemology: a Critical Neo-Rationalist Approach ” in Knowing the Difference: Feminist Perspective in Epistemology Lennon and Whitford 1994 and Sandra Harding “Feminist Justificatory Strategies” in Women, Knowledge and Reality Garry and Pearsall 1992). The point is a general one and not dependent on arguments asserting specific dependence of educational procedures on their alleged links with the kind of learning theory that was developed to underpin weapons training in high-tech environments. It is in a much broader sense that psychologists have joined engineers in the quest to develop the “man/machine system”. One central notion is that the person becomes an “information transmitter” positioned between the displays and controls of the machine. In the attempt to know the human operator as well as they know the

machines that surrounded him/her, psychologists, biologists and engineers draw on research from computing, psychology and cybernetics. The human operator is seen more and more mechanistically, and the mind as little more than a logic machine “which takes some premises and grinds them up, processing them into conclusions” (McCorduck, 1979, p.127). This has been associated with an increasing interest in the simulation of human decision-making, firstly by programming simulated chess games and later in logic puzzles and arithmetic (see George Atkinson’s Chess and Machine Intelligence 1994).

As indicated above, curriculum reform in the United Kingdom has often been characterised by flexible adoption and local adaptation, but this freedom of manoeuvre is likely to be less where one is dealing with a technological package which may not be educationally divisible in the same way. In the aggregate version of curriculum research and development in action (see Stenhouse 1975, Fullan 1982 and Hoyle 1970) the factors supporting or inhibiting adoption and institutionalisation are relatively clear. Innovations will tend to run into the sand unless they are subjected to the more deliberate pattern of diffusion called “dissemination”, but this also has a psychological dimension, since the process of adoption begins with an awareness of it as a possible innovation within a potential client institution. With high-tech innovations, educational dissemination has tended to be replaced by the entrepreneurial activity of the commercial provider. For example, the Doomsday Project, although explicitly one of the first multi-media systems designed for education, and running on a BBC computer, was afforded a parallel dissemination almost as though it were principally a commercial product, with press write-ups and extensive demonstrations at computer and education exhibitions. Though it went through a rapid diffusion process, it suffered from being too expensive for rapid assimilation into the

system.

As Hoyle (1970) has pointed out, several characteristics of an innovation are relevant to acceptance. Usually it must provide a relative advantage over existing practice. Hoyle has also shown how the likelihood of an innovation being adopted to some extent depends on its “divisibility”, that is the degree to which it can be tried on a limited basis. The success of computer systems like the Apple Macintosh enable the user to learn basic commands which are applicable to all software, so that they could begin with a small machine and one or two software packages and build up a larger and more complex and versatile resources later. Software companies also send out restricted versions of new software to customers on a trial basis, hoping that they will be encouraged to buy the complete version when they are unable to make a particular demonstrated function work from the test package. Also, the greater the communicability of an innovation, that is the degree its results can be demonstrated to others, the greater the likelihood of adoption. Desk top publishing software is a good example of the success of an easily communicated result; as soon as a document is printed its superior print quality and layout options, in comparison to simple word processed text, become immediately apparent.

The compatibility of software is increasingly important consideration because of the growth of centralised computer resources in colleges. One type of machine is now expected to be able to facilitate work across areas as diverse as Accounting, Photography, Graphics and Engineering although each of these areas has different needs and goals, and use different combinations of software. One of the reasons for the popularity of Macintosh computers is that they can be put into these kind of resources. On the other hand, the cost of a machine that will process the large

amount of data used in imaging far exceeds that of the machines needed for simpler tasks, and there is a danger of under-resourcing some courses in a bid to support the greater number of departments which have needs for less advanced computers. Cutting costs by buying machines at a lower technical specification, to the lowest common denomination of technical requirements, results in constraints that I have particularly felt in Art and Design departments. It is likely that computer hardware will become standardised in the near future and companies will produce either software or hardware, in acknowledgement of consumer demand for flexible, universal machines.

One of the reasons most often cited in education for not taking up innovations is centered around resources. Teaching packages based upon computer and video equipment require substantial amounts of money and permanent space, so it is not surprising that resources are critically important in the process of adoption. Time is also needed for retraining and staff development and this, too, is an expensive resource. At times there can be difficulties in establishing the collaborative working relationships necessary so that staff are aware of the relevance of new equipment to their particular teaching area.

Staff development and training is essential where academic staff are responsible for recommending equipment purchases and teaching in technology dependent areas. Employing recent graduates with up-to-date training as “demonstrators” is a recent attempt to provide students with support at low cost to the institution. Technically proficient and experienced teaching staff already employed within the institution are often from science background rather than the arts, they therefore have very different concerns and different skills: imaging technology differs vastly from the computing facilities used by most science and maths departments.

Funding expensive capital outlay for new technology

There is an expensive capital outlay for equipment that needs almost constant upgrading if it is to be used to teach even basic technical practice to minimum industry standards. As colleges struggle to save money the staff to student ratio is increasing, while student intake increases place a greater strain upon courses like Media, which depend on costly equipment. As a result students have to double up at computer workstations and work in larger and larger video production teams. As colleges have to earn more of their income, their technical facilities are used to win outside contracts to make videos, produce DTP and create computer animations. On the one hand this provides students of media, art and design with valuable experience of working to professional standards with clients. On the other hand there is a danger of commercial jobs getting in the way of the educational process and a danger of linking more and more college activities to the commercial environment.

Industrial sponsorship

As the new universities search for additional funds, many big companies are willing to locate parts of their research and development in HE establishments. This benefits the individual company which has no overheads in terms of buildings etc. The college builds a reputation for post-graduate research and may acquire gratis whatever computing machinery is needed for the project or be able to split the cost of advanced machinery with the industrial contact. The research student gets post graduate funding in the form of a wage from the industrial contract, which can be as much as two or three times higher than educational

funding for comparable post graduate research. Once the project is over, the commercial company may sever links with the college, taking its machinery with it, its needs satiated. In the meantime, students have been placed under pressure to bend his/her direction of research towards the requirements of the company funding them.

Computer manufacturers

Computer manufacturers will frequently make gifts of machines to schools and colleges. This is a successful marketing ploy, since students that are trained on a particular brand of equipment will often remain loyal to that brand, buying their own machine when they can afford it. Also, depending on their employment after graduation, they may recommend a familiar computer or video system to their employers. In America, Apple aimed to donate a computer to every school, an interesting and shrewd way of attempting to corner the market. The Macintosh computer company regularly sends publicity and invitations to schools and colleges for staff to attend seminars held at the Macintosh trade exhibitions. One such education seminar promoted Macintosh multi-media packages and 3D modelling software.

Computing as a curriculum subject in its own right.

Morris sites a key problem, and goal, to be the introduction of computing as a separate part of the school curriculum, as a subject in its own right, and not simply an addition to another subject like maths or science. This type of development is under threat from repeated cuts in funding to schools and colleges. The HMI report, On the Effects on the Education System of Local

Authority Expenditure Policies, Financial Year 1980-81 found that such policies would result in bigger classes, loss of teacher morale, teachers working across subjects and fewer resources, and especially pertinent,

“actual losses of some subjects and opportunities including ...design and technology” (p.12)

Centralised resources

In Higher Education there are often one or more central resources which are used to support many different subject areas. When trying to spend as little as possible and yet please as many departments as possible, the Information Resources Services (IRS) often end up buying computers and software that provide word processing, basic desk top publishing and any other software and hardware (such as printers) which is used by the majority of courses, but little else in terms of specialist software for particular courses. These resources are well maintained by competent IRS technicians (which computer facilities in numerous, small, isolated groups sometimes are not) and run on a combination of open-access and bookings systems. Unfortunately the lack of support that these facilities provide for specialised use means that they become redundant for some purposes and separate specialist resources have to be set up. It is worth pointing out here that what is “specialised” software at one point in an academic year may be in demand by all later that same year, as popularity for advanced programs grows across courses when different students can look over each others’ shoulders in a centralised resource and see packages being used that interest them. This frustrating situation leads either to the marginalising and dropping of computers as a subject, or to the setting up of carefully planned and accurately resourced computer suites for each different subject area which can prove expensive.

To use centralised resources to teach a computer based module in art and design often depends on the art school or specific departments within it buying expensive image making software, software that inevitably lies dormant for much of the time when other departments are using the resource. This type of software often requires more powerful computers to run correctly than those needed for word-processing or making spreadsheets. Staff and student resentment builds up when the money compulsorily creamed-off every department's budget to fund central resources is seen to benefit some courses more than others. In the case of the University of Westminster, the central IRS resource is equipped so that it is possible to teach sixteen students in the area of desk top publishing, word processing and the like. Until recently only two machines were capable of running the software used by media students to produce animations and interactive projects. Hence the resource impeded teaching groups and resulted in frustration for students who had to work in pairs in different rooms and annexes, while staff resorted to repeating basic lectures over and over to smaller groups and teaching different students in different rooms simultaneously (sometimes separated by over 100 yards and five floors). This has now changed and the role of centralised Information resources Services had become much more integrated with individual courses, with staff from IRS taking time to get insights into the particular needs of a variety of users.

Enabling students to develop a broad base of skills rather than specialist skills

As technology used in media production develops rapidly and broadcasting moguls are broken down there is less call from industry for graduates with specialist training. Students trained to proficiently use one or two pieces of equipment thought of as "the industry standard" find that their skills are often

soon devalued. New types of equipment replace or compete with that which they were trained on, the notion of one type of video kit used by the whole media industry is disappearing. As video branches into more formats it is no longer feasible for colleges to train students on one type of camera kit, the emphasis is on a breadth of experience with a variety of types of equipment in order to enable easy transition between one type of kit and another. Electronic news gathering has capitalised on the increased quality of the camcorder, and cable TV companies frequently send news crews out with these inexpensive and relatively disposable cameras. Less news material is gathered on film and gradually the film processing labs in TV companies are closing as videotape takes over. In addition much editing of videotape and rough editing of film is done digitally using non-linear edit systems based on computers. Understanding the principles which underlie new technologies and developing versatility and ability to use different machines prepares students for careers in an industry which is constantly upgrading and changing the equipment it uses.

While developing this broad range of experience and skills, the University of Westminster's Contemporary Media Practice course at Harrow has recently created a fourth area in its curriculum in 1992 for the study of media - digital imaging. Though students have long been encouraged to combine different media, making digital imaging an area of specialism in its own right has reinforced its identity, supporting its independence and elevating it from being seen as a supporting subject for other areas like photography, video or film. The decision to make digital imaging an area in its own right was not taken in order to separate it from other imaging techniques (like video, film or photography) but rather to respond to industry changes which have led to an expansion in the use of computer imaging techniques, and student wishes to make adequate teaching

time available to support the increased demand for teaching and experience in this area.

It is against this background that the thesis moves on to its two chapters written explicitly from a feminist perspective. The first, *Gender and Technology* attempts a radical deconstruction of the cultural ambience of high-tech environments from the standpoint of the kind of cultural studies that is being written from “feminist standpoint theory” (see Sandra Harding 1992 and Marnier Lazreg 1994). The agenda here will be to “prioritise the subjectivity of women as an oppressed group” in order to produce a situated non-essentialist account of their experience of alienation in these environments, although I hope to do this in a grounded non-controversial kind of way. The cameo at the end of this chapter from, Solihull College of Technology. Offers a gendered account of the BTEC Media Course, is based on case studies conducted in Solihull College of Technology. These settings provide a careful local check on the propositions which have by now become standard in the literature. The stance is similar to that adopted by neo-Marxists whose critique of schooling is to some extent governed by an ideological stance, although they wish to exhumate the mechanisms by which (say) cultural reproduction theory produces its effects (see for example Paul Willis’s *Learning to Labour* 1977). But since feminist theory, unlike Marxist theory, has recently tended to abandon metanarratives (in common with postmodernist writers like Lyotard 1984) situational theory and educational ethnography have become critically important in the attempt.

These are followed by a chapter titled, *Women Artists and Video Production as Action Research*, which reports on a number of developments in my persona as a creative video artist which were brought within the orbit of this thesis by treating

them explicitly as action research and thus part of my general quest for understanding.

Solihull College of Technology: a cameo

Using semi-structured interviews alongside participant observation I talked to women FE students on the BTEC Media course seeking to explore their experiences of working in mixed groups. This was immediately following the decision they had taken, in response to the problems and frustrations that they had experienced when working with boys, to initiate single sex working groups. This is not presented as a major investigation, more an illuminating corroborative cameo that helps in “triangulating” the data from other sites by showing the general configuration of issues to be repetitive.

Researcher: “You’ve talked about working with other students when they are the subjects of your work. How about working with other students in teams?”

Nicky: “That’s had its problems as well.”

Kate: “Yes. In our first project there were the two of us [girls] and we were working with three other boys. Basically we had a communication problem.”

Researcher: “How did that manifest itself?”

Nicky: “It was just big headedness, I think.”

Kate: “Yes, it was. They kept saying things like, “We were here last year we know what we’re doing. You are girls; you don’t know what you’re doing. Why don’t you leave it up to us?”

Researcher: “They had done the BTEC First course had they?”

Kate: “Two of the boys had done the BTEC First, and obviously they knew a bit more about the cameras and the equipment than we did, but they were just shoving us out of the way. “Just let us get on with it.” That sort of thing.”

Nicky: “We had got in touch with the school, and we had been given a week in the school to film. The lads kept saying “We’ve got to get it right first time. Just let us do this bit and then you can have a go (when the “real shoot” is over).”

The students who experienced this obstruction to their work became stroppy and assertive during the project and insisted on working separately. The video element of the BTEC Course was the responsibility of a woman video lecturer of whom they talked of warmly, and who had certainly provided them with a positive role model of a woman who had achieved autonomy and authority in a technical area. This role model may have gone some way towards providing a basis on which the negative gender stereotyping expounded by the male students might be challenged. In her technical workshops, women students were equally called upon to assist staff in setting up equipment and demonstrating procedures to other students, and were treated as if they were as adept as men and not only in being strong enough to carry the camera equipment! The next bit of the transcript shows how the simmering discontent of this particular group turned to political action in the frustrating situation.

Researcher: “Were you eventually able to do something?”

Kate: “Yes, but we really had to fight for every minute we had in charge of that camera. On one occasion the white balance wasn’t set properly and it turned out blue, so somebody had to go back and do it. They [the men] just weren’t prepared to go back and do it, so Nicky and I had to go back and film what we needed.”

Researcher: “So you actually got time with the equipment. But why wouldn’t the boys go back and redo it? Were they embarrassed or what?”

Nicky: “We’d been doing this for about a week and a half, two weeks, and we were really fed up with all the arguing and everything. It was just war between the two of us and the three lads.”

Kate: “We had this massive argument about who was going to go back to film it. In the end we just said, “Forget it. We’ll go back.”

Nicky: “There was no appreciation; we were supposed to be working as a team. It wasn’t just me who had made the mistake with the white balance. The thing is one of the boys had done it as well.”

Kate: “Yes. They said (about their own mistake) that it was “alright, because we don’t need that bit anyway.” But that wasn’t the point.”

We went on to talk over other projects. One of the students said that although she had not realised at the time, this had been the catalyst that led to her working together and the other women on the course had worked together, without the male students, for the rest of the year. After some consideration, they said that they thought they would consciously choose to work in women-only teams in the future as it had worked out to be far more satisfying; they had experienced mutual support and the relief of no male opportunity to denigrate or sabotage their work.

A tentative provisional generalisation from this cameo would seem to be that on courses in technological areas, some thought should be given, either to the provision of protective single-sex space, or for the teachers actively to confront issues of discriminatory behaviour, by encouraging gender-focused class discussion. Either way, it is important that girls should be allowed to get to grips with technology without their work being interfered with or prevented by boys.

Diary March 1990

When I proposed that a short introductory desk top publishing course for women-only would be a welcome addition to the evening classes offered by the FE college in which I taught, the response was mixed. My head of department was supportive, as long as it was a fee-economic course (eg if too few women enrolled it would not run and that would be that.) However, a number of my colleagues were openly hostile. A male technician berated me at length and with gusto in front of the students I was teaching, and claimed that if I ran women-only classes, which discriminated against men and were therefore “sexist”, then he would have the retaliatory right to put up “titillating” images of women that were now banned by the college. The heated debate continued, largely behind my back, despite my repeated attempts to bring it into the open in order to be part of the discussion. Feelings were that the course which I proposed was sexist, and that it was doomed to failure as only extreme radical feminists would enroll. The opinion was that there was

bound to be too few of these “unnatural women” to fill the class. When the time for enrollment arrived it coincided with a college wide policy change which meant that all part-time LEA evening classes had to be of at least 14 students. Ironically, the women-only desk top publishing course, which was for 18 students, was the only one over-subscribed and many of the LEA subsidised courses, which were much cheaper, did not start at all due to low enrollment.

Not surprisingly, the women who attended the DTP course were from a variety of backgrounds, rather than conforming to some radical feminist stereotype. Some had been sent by their companies and these included women whose male bosses had found about the course and recommended it (seemingly industry has caught onto the value of single sex training). Secretaries with previous computing experience were expanding their skills, though in some cases this clearly supported continuing exploitation by the companies who paid their fees. These companies were training low-paid female workers to design adverts and produce the company newsletter with no discussion or offer of a corresponding wage increase at the end of training and no mention of further training in design, layout or typography. Even a progressive move, given the complicated board on which the gender game is played, can carry penalties associated with other considerations, and we should constantly remind ourselves not to underestimate the patriarchal hegemony.

GENDER AND TECHNOLOGY

The issue of gender and technology is a critical element in the matrix of issues and concerns that constitutes the subject matter of this thesis. As I indicated in the *General Introduction*, gender issues are an important problematic in making sense of the relationship between the new technology, art practice and education. This chapter is an attempt to understand, from a feminist perspective, the nature and practical consequences for women of aspects of the technological environment that they have widely experienced as alienating. Since there is no single feminist position on these issues - indeed they are the subject of vigorous contemporary debate - it is clearly necessary that I should define my own position in relation to the alternatives available.

This thesis shares the stance common in feminist cultural studies that many beliefs “thought to be well-supported by empirical evidence and therefore free of sexism and androcentrism” are not in fact well founded. Sandra Harding’s “Feminism, Science and Anti-Enlightenment Critiques” (1990), is by no means alone in insisting on this reevaluation. The problem is a consequence of the fact that accounts of human culture and social life have been written from the male perspective (“that of man-the-hunter who created human culture and for whom females are an evolutionary drag on the species”) and have marginalised or silenced the experiences of women. Feminist theorists tend to use a local version of the sociology of knowledge, organised around the insight that there is a complex interdependence of knowledge and power such that oppressed groups like women find themselves trapped in a language and a set of social assumptions that fail to represent their experience. One feminist agenda, then, is to deconstruct this language and these assumptions and to generate a conscious-raising alternative. Feminist scholars seeking to develop gynocentric alternatives to androcentric perspectives have not always fully abandoned the essentialist or

universalist pretensions of the latter, not least in trying to propose “woman” as a biologically-determined essential category. My own position is more sympathetic to the contrary example provided by Carol Gilligan, who in In a Different Voice: Psychological Theories and Women’s Development, chose not to look for some alternative grand theory to explain cultural sexism, but rather set herself the more limited task of exposing and redressing androcentric bias in the model of moral development proposed by the psychologist Lawrence Kohlberg. She argued that it is illegitimate to evaluate the moral development of women and girls by reference to a standard drawn exclusively from the experience of men and boys, and proposed to examine women’s moral discourse in its own terms in order to uncover its immanent standards of adequacy.

As indicated earlier, what is proposed here is a version of “feminist empiricism” and “feminist standpoint theory”, which as Harding (1990) points out have been proposed as justificatory strategies for feminist projects, although, they are intellectual manoeuvres not without their attendant problems. My own “feminist empiricism” accepts that it is necessary to prioritise the subjectivity of the oppressed in order to get a more truthful account of gender issues, although there will always be a certain amount of interpretation and relativism in accounts of social life. It is just not possible to write accounts of social life by taking some mythical “view from nowhere”.

My own “feminist standpoint theory” accepts that knowledge needs to be grounded in experience and that paying more attention to women’s experience provides a starting point for developing more complete and less distorted knowledge claims (see Hartsock 1987, Smith 1974, Rose 1983). Although seeking to “deconstruct” social life from the perspective of women’s experience, I

am not prepared to go all the way with Richard Rorty's seminal text Philosophy and the Mirror of Nature (1979) in supposing ideas to be merely the social products of particular interest groups rather than reflecting nature. Rorty's position is indeed as "simple yet subversive" as Bordo (1990) supposes.

Although having some sympathy with the postmodernist position in its rejection of legitimating metanarratives, I think it would be a mistake to see all theory as embryonic metanarrative, and a much more sensible and sane position seems to be the middle one that asserts some accounts to be better than others, and takes the view that good accounts will always recognise the situational embeddedness of truths; also that telling the truth about social life remains a legitimate activity not quickly to be surrendered to the current fashionable intellectual fragmentation. Harding (1990) states the general argument rather nicely:

"According to Enlightenment defenders, these postmodernist critics [Lyotard (1984), Rorty (1979) and Foucault (1981)] are attempting to undermine the harnessing of science for democratic, anti-racist, ecologically sound, anti-militarist, and other progressive ends; or, even if this is not what the postmodernists consciously intend, their positions have that consequence ...However, other feminist theorists ... argue that feminists must be wary of the anti-Enlightenment criticisms. They state, or clearly imply, that feminists are making a big mistake in adopting postmodernists postures."

Harding (1990) p.84-85

With a rather nice speculative wit, Luce Irigaray (1985) even ventures the suggestion that postmodernism itself might be "the last ruse of patriarchy".

The specifics of the problem

Women's disadvantages in the workplace

Stephen Ball made an anonymised study of "Casterbridge High School", a comprehensive made up of the amalgamation of three local schools in which the demoralising effects that disproportionate ratios of male to female staff have on women staff are highlighted:

"Senior posts were overwhelmingly dominated by male staff. By the third year of the existence of the comprehensive school there were 84 staff in all (full and part time), 52 men and 32 women, but in senior posts there were just 3 women in all (one assistant head, one year tutor and one major departmental head). Thus there was only 1 woman out of 7 members on the senior management team, 2 women out of 13 on the academic board, and 6 women members out of 21 on the pastoral board."

Ball (1984) p.237

Ball observes the serious loss of morale that this caused, with women staff seeing no future for themselves in terms of promotion. As part-time posts were cut to reduce staffing, it was again women who were disproportionately affected. The implications for the few women who were teaching and in pastoral roles was an increased workload, as girls turned to them for support and advice about subjects that they were often unwilling to discuss with male staff

For sometime now it has been widely recognised that women are disadvantaged in the academic design studio workplace both as teachers and students. In part this relates to the failure of nominal equality of opportunity policies to result in the proportion of women one might expect, particularly in senior positions; but my argument here is that these problems are noticeably exacerbated in technological environments where tokenism gives way to barely concealed

hostility, as the data I offer below makes abundantly clear. For the woman student, too, the claimed aspirations of education to be seeking a general high level of computer literacy for the entire student population is a good deal less than clear, with the very definitions of what is to count as computer literacy distributed in a gendered kind of way. This awareness of a gender-distributed curriculum is bound to create the dissatisfaction that always occurs when one group are explicitly excluded from, or only partly included in, some new advantage. Thomas (1989) makes a similar observation with respect to the changeover from the abacus to a written system of calculation, which she saw as causing

“widespread dissent in Europe in the Middle Ages because it placed economic control in the hands of the literate elite. It has taken less than a thousand years, a micro period in the aeons of our history, to move from the tally stick to the pocket calculator, but this transition has happened smoothly compared to the next phase - from calculator to computer. Are we now fostering a computer-literate elite?”

Thomas (1989) p.20

Women who teach and learn in technology-based areas

For a long time women have been teaching in technology-dependent areas such as home economics and dressmaking, but because of the way that activities are often categorised according to the gender of the person doing them, these have not even been thought of particularly as technology-based. They may have been the only practical technology-related subjects on the curriculum in many schools. In both subjects the women who teach are highly skilled in the creative use of a wide range of technologically-advanced and potentially dangerous equipment. If the equipment breaks down most of these women will have the knowledge needed for basic repair. It is a matter of whose definition of “technology” is applied which determines whether one area is considered “technological” and another is not.

Areas like Computer Graphics, Desk Top Publishing and Video are more commonly seen as technology-based by a broad range of men and women. While women teaching in subject areas like Domestic Science have to contend with other peoples' assumptions that theirs is not a science or a technology, women teaching in areas like Computing and Video have a different series of assumptions concerning technology and gender to contend with.

Diary. July 1990

I worked part time in the art and design department of a F.E. college. After a year I was offered an associate lecturer post. That year, on a greatly reduced hourly rate of pay, 5 women who had previously worked part time got temporary associate posts. As their part time hours were absorbed by these associate lectureships (which were for marginally more hours) it was almost guaranteed that they would apply for the jobs as there would be no part time work in the college for them otherwise. The college was familiar with their teaching ability and would save money. On the surface this development seemed positive for women as previously there was only 1 salaried woman teaching in the department out of 11 full time lecturers. In reality there was little change in the status quo. As an associate lecturer on a temporary contract the post is only for one year. All of us were told that after the first year if the post was still needed it would be made permanent. Twelve months later all 5 posts were offered again, but still on a temporary, one year basis. The full time posts with job security and clout were still distributed 10 to 1 in favour of male staff. Similarly all the course leaders were men. I was the only woman teaching in a technology-based area, and when I left for a better job I was replaced by a man.

My experience, nearly two decades after Casterbridge was studied, is that a similar imbalance and a similar set of constraints remain in many institutions, and there is no sign that the Women's Workshop, an organisation ratified by the

Artists Union 1972 and which had demonstrated against gender discrimination at the June 1973 National Conference on Art Education, is within remote sight of its demand for equal numbers of women and men on the student body and staff of art colleges. The general pattern remains one in which women working in art and design departments tend to be exploited as a part-time and casualised workforce, and as Parker and Pollock (1987) point out, their lack of security of tenure has the further tendency to exclude them from decision or policy-making meetings.

The first contested assumption results from the collision between perceptions of women in support roles and their claim to be legitimately regarded as authoritative on a subject; the “support role” attribution tends to undermine the claim to expertise. A practical consequence is that women staff and students need to exhibit and dramatise more positively that they know what they are talking about. This persistent antinomy merges with another gendered collision between stereotyped roles; there is a further range of crass and subtle problems that will need to be faced by the woman who presents herself, not only as an expert, but as an expert in a field like technology, itself seen as masculine. Students, particularly men, will want to see the woman teacher’s own work, and are put out if they do not comply. Certainly this is my own experience. In asking litanies of questions, some male students tend to use as much technobabble as they can squeeze in, to test you out and to display their own sometimes shaky knowledge. Some staff (both academic and technical support) and students see a woman lecturer as a real threat to the male techno-domain; they tell sexist jokes that demean women, and deride women fellow students about their supposed technical incompetence. Male students often go and check a piece of information you have given them with a male member of staff. Any man will do, whether or not he knows anything about video or computers.

Another common misconception is that you must be a “ball-breaking” feminist to work with technology (“feminist” is assumed to be a term of abuse and therefore women are expected both to be insulted by it as a label, and deny any allegiance to it).

Although some male and female students have these responses, there is another set of responses which complement them. Women students often vocalise their relief at having a female lecturer, especially if group dynamics are made part of the teaching and working process. Making space for women and encouraging them to demand a place for themselves is often well received and makes the whole group more lively, especially in discussions.

Mixed class conversational dysfunctions

Research by language-in-use theorists like Dale Spender (see Man Made Language 1985) has shown that in mixed conversation men have a variety of methods with which to control women’s speech/silence. Revealing these techniques gives a valuable insight into the dynamics of mixed conversation. The idea that women talk too much is deeply ingrained in our culture, and often reiterated, usually by men. We are all familiar with faintly abusive terms and descriptions which label women’s conversation as inferior; women “gossip” while men “discuss”. Women “prattle”, engage in “idle chit-chat” and talk “all the time”. Yet studies of mixed-sex conversation shows that women are subject to repeated interruption from men and talk for dramatically less time. It is women who provide the majority of openers in conversation, who encourage the men to speak and are then drowned out by them. All in all, it is frequently men who dominate conversation, and when women assert themselves by speaking up or

interrupting they attract dismissive epithets like “bossy” or “arrogant”. Spender’s research comes out of a gender-focused feminist empiricism which is defended by Harding:

“[the epistemology of feminist empiricism] has great strengths. Its appeal is obvious: many of the claims emerging from feminist research in biology and the social science are capable of accumulating better empirical support than the claims they replace. ...It is not that all feminist claims are automatically preferable because they are feminist; rather, when the results of such research show good empirical support, the fact that they are produced through politically guided research should not count against them. Moreover, feminist empiricism leaves intact empiricist understandings of the principles of scientific inquiry that are de rigeur for most practising natural and social scientists.”

Harding (1992) p.191

Technology as a masculine realm

Technology is frequently presented as part of the masculine realm, and this association contributes to a gendered perception of technology. As a result, many women see technology as mysterious and “other”. But what makes something technological? Why, for instance, asks Pam Linn (1987), is the use of a sewing machine not seen as technological, while the use of a sander is?. It seems that it is often the gender of who is using something, and in what stuated context it is being used, that prompts the label “technology”. Objects and activities have often been classified as technological or not, according to the gender of the dominant user, with the underlying premise that women’s work is not technological.

In their introduction to Women, Knowledge and Reality (1992), Ann Garry and Marilyn Pearsall point to the kind of “value-hierarchical thinking” by which feminists “seek to explain and understand women’s subordination as systematic and structural”. This deeply embedded value-hierarchical thinking accords greater value to the higher (“men, culture, minds, reason”) and less to the lower

(“women, nature, bodies, emotion”). In this logic of domination, technology splits on gendered lines, roughly in accord with the feminist anthropologists of the 1970s who posited “a cross-cultural domestic/public separation” (see Nicholson 1990).

Thus it is power relations built into the androcentric culture that define “women’s work as non-technical and non-technical work as women’s work”. By logical extension, “men’s work [is seen] as technical, technical work as men’s work” (Linn 1987). The domestic environment, traditionally seen as a female domain, has therefore been presumed non-technological; even though it is increasingly filled with hitherto hidden technologies: there are numerous micro-chips in the domestic environment. Smith observes that much household technology is marketed using claims that the time spent doing mundane tasks such as cleaning is reduced, and that because of this the technology is appropriate. In fact, generally, there is no reduction in the time spent cleaning because the development of new domestic technological appliances, such as vacuum cleaners, has been accompanied by a dramatic rise in standards of cleanliness, countering any time saved, much in the same way as (predominantly male) driving habits are modified, according to road safety experts, to “consume” new technologically achieved safety margins. At the same time as there has been a dramatic rise in standards of cleanliness and hygiene, there has been a reduction in the number of middle class families who pay for domestic help, and less unpaid assistance from grandparents or children.

Domestic technology is frequently presented in a “gendered” light with men depicted as unable to solve the feminine mystery of the modern technological kitchen. In Kramer vs Kramer the separated husband is seen striving to make

breakfast, unable to use the blender, his incompetence used as a ploy to gain the viewers sympathy for his plight as a domestically infantilised New Man.

The use of jargon permeates technological environments, and is perhaps particularly evident in computing. The section about technobabble explores the milieu of technical jargon as a masculine codification of technology.

Technobabble has been said to support and deliberately promote technophobic feelings - the use of an unintelligible “foreign” language is a powerful way of alienating the uninitiated. Women are often those users of technological machinery who have been most alienated. Computer manufacturers have capitalised on technophobia and created a potent double-bind by harnessing their products, at least rhetorically in their advertisements, to the anti-phobic “user-friendly” label

Unhelpful analogy (1): the military

I have already indicated that the quest for man/machine systems has developed historically in part as a response to perceived military needs, as technological warfare exists in our culture, science-fiction fantasies apart, as the paradigm situation in which a human operator might become defined as what McCorduck (1979) called “an information transmitter, positioned between the displays and controls of the machine”. The ubiquitousness of the video arcade culture, which has normalised “virtual war” as a legitimate leisure pursuit, guarantees that the capabilities of cybernetically-enhanced human performance are never quite detached from the idea of war.

Noble (1989) and others (for example, Woolley 1992) have traced how the cutting edge of the leading research in areas concerned with “the human factor” in man-machine interaction was developed with weapons systems in mind. There is also

a need for the human competencies required for armed warfare to be predictable, accurate, and performed without question, which led to training systems based on a rigid prespecification of outcomes and attempts to make quite complicated machines and weapons systems “user-friendly” (“friendly” perhaps as in “friendly-fire”).

Warfare, particularly aerial combat, is clearly one of the inspirations behind the development of virtual reality systems since they offer beyond the present capacity to train pilots in VR simulators, the future prospect that they might eventually fly distant aircraft whilst the pilots themselves remain literally on the ground. VR technology has potential for a multiplicity of uses and in spite of some daunting problems of ontology and ethics discussed below, is also an (ambiguously) attractive technology for artists, including those using video. In this section, however, it is the genderisation of the “cockpit” (not yet on military aircraft called the flight deck) that commands our attention. As far back as 1945 Vannevar Bush described the Voder machine which was being displayed at the World Fair in a language which can be seen in retrospect as having only a thinly disguised sexual content.

“A girl stroked its keys and it emitted recognisable speech.
...A girl strokes its [the stenotype’s] keys languidly and
looks about the room and sometimes at the speaker with a
disquieting gaze.” (p.104)

Forty years later, in 1988, the same genderisation of pilot support systems was apparent in an American TV programme which heralded the arrival of the “magic cockpit”. Computers would play the role of a simulated in-flight assistant, responding to a pilot’s verbal command and replying in a female voice, giving accounts of ongoing situations. This gendered device was able to claim a

psychological justification, since a pliable subservient woman would clearly offer no challenge to the “right stuff” male pilot.

The US Air Force are even predicting that “intelligent” cockpit computers will soon be able to interpret a pilot’s spoken command or respond to his/her eye movements or brainwaves, and that this type of merging of pilot and aircraft will result in an enormous increase in the pilot’s memory and capacity to make decisions. Some of this came through the televised imagery of the Gulf war, where we saw televised images of pilots “flying” remotely operated missions from the ground, or from within accompanying aircraft. Bombers remotely manoeuvred their weapons, gauging their targets through the artificial eye of a camera mounted on the bomb, which enabled images to be transmitted back to the pilot and the television crews. The physical detachment of the bomber from his launched projectile was countered by a “bombs-eye-view” of the target recorded up to the moment that a missile hit a target.

Another facet of the argument that makes the military an unhelpful analogy is that the association has resulted in a hard-edged aggressive macho jargon becoming characteristic of computer-rich environments, even in art and design studios. One dominant image linking current outer-edge military technology with science-fiction is the myth of the cyborg, a myth I shall return to later, both in relation to science-fiction films and writing, and (as a surprising inspiration) in relation to my own work as a video artist. Donna Haraway’s entertaining, serious and tongue-in-cheek article, “A Manifesto for Cyborgs: Science, Technology and Socialist Feminism in the 1980s”, which first appeared in Socialist Review (see also in Feminism/Postmodernism Linda Nicholson, ed, 1990) approaches the cyborg myth obliquely, claiming feminist affiliations with its dispersed

postmodernist aura of segmented identity. At least cyborgs offer some hope of surviving nuclear culture, as Zoe Sofoulis argues

“the most terrible and perhaps the most promising monsters in cyborg words are embodied in non-Oedipal narratives with a different logic of repression, which we need to understand for our survival. The last beachheads of uniqueness have been polluted, if not turned into amusement parks - language, tool use, social behaviour, mental events.”

Haraway (1985 revised 1990) citing Sofoulis

At this point I should perhaps mention that one does not have to necessarily adopt a thoroughgoing Freudian psychoanalytical stance in deconstructing the way language has been gendered in part by its deployment of sexual metaphors.

Freudian double-entendres are now part of popular culture, whether or not his view of the workings of the subconscious is soundly based.

I have claimed above some sympathy for those feminists who defend Enlightenment virtues against postmodernist critics like Rorty (1979), not least because many women wish to harness their science and praxis for “democratic, anti-racist, ecologically sound, anti-militarist and other progressive ends”. I am not seeking to reclaim some biologically-determined universality for women on this issue, simply that in my experience women are far more likely, because of their spheres of activity, to take this stance than men, since their lives, relatively, tend to be “more domesticated” and their power viewed as “illegitimate, disruptive, and without authority” (see Fraser and Nicholson 1990). My own feminist standpoint embraces a distaste for the military, as for war in general, but the deconstruction attempted here possesses a validity independent of this value-position, since the argument in its minimal form merely points to the very considerable ironies, tensions and ambiguities that exist at the point of intersection between military and educational ideologies.

“while it is not possible to make a computer think like a Cavalier, it is possible to not include factors that will force the program to think like a twentieth century Whig.”

Corbeil (1988) p.130

Unhelpful analogy (2): science fiction

The changing image of the self-directing computer, or robot, has been given form by science fiction writers and films such as Terminator and Terminator 2, presenting what is to all intents and purposes a cyborg imbued with the distilled power of the patriarchy, an efficient, unemotional assassin. Such films have “tech-noire” genre, one which merges the technological settings of science fiction with the bleak mean streets and long shadows of film noire. In tech-noire, characters illustrate a blurring of genres; the androgynous female, the woman-as-leader, perhaps representing less narrowly defined sex roles. These “future shock” films capitalise on our fear of technology and of computers/robots taking over the world. The “Star Wars” referencing film Terminator began with the near destruction of the population as a central computer logically surmised that there was no particularly pressing reason to perpetuate the human race. Bladerunner presents us with the ultimate “other”, a future where cyborgs are indistinguishable from humans, a fear on which Terminator builds. All of this contrasts with the popular TV series Lost in Space which provided us with the 1950s notion of the robot as companion and friendly servant, behaving in a fatherly way towards the boy in the series, and like a faithful dog defending its masters at any cost. The computerised female cockpit companion already belongs to the same traditions of dog-like devotion.

Artificial intelligence (ubiquitously just AI) aims to mimic, with computers,

certain ways in which the brain works, sometimes with a view to “improving” on the brain’s performance. The strong model of artificial intelligence (Searle, 1987, p.211) is dispositionally willing to attribute mental qualities to any machine which performs logical functions.

New technology to aid people who have special needs is already available. Head-mounted cursors enable those who are paralyzed to use a keyboard to word-process and design. Stephen Hawking, the contemporary physicist and author of A Brief History of Time uses a keypad and voice emulator to counter the obstacles to communication that result from his suffering from motor-neuron disease. Applying technology in these ways to augment the human physique carries few ethical dilemmas, (but see Donna Haraway 1990) although there is a nagging worry that the learning strategies and equipment being developed by the military might be tested on other groups of people, such as those in psychiatric care, whose rights and voices in Western societies are already under threat. The recent American film Lawnmower Man expresses this anxiety in a very concrete form. It is based on the novel by Stephen King and is sensationalised in style. The central character Jobe is a retarded man who becomes a guinea-pig for research into using Virtual Reality learning environments, in combination with so-called “intelligence-enhancement” drugs to raise his intelligence level. In Lawnmower Man the experiment results in Jobe accessing psychic and telekinetic abilities and experiencing cybersex in Virtual Reality (Mondo 2000, Issue 4 1991, p.14).

Unhelpful analogy (3): the video arcade

Charles Grimsdale, a researcher who works on the development of VR systems, spoke at a recent seminar at the ICA in London (1st October 1991). He strove to anchor to the proverbial ground those idealists who had been floating euphoric in non-gravitational computer space. According to Grimsdale, the phrase “Virtual

Reality” was coined by marketing consultants, and has since been employed unrelentingly as a marketing tool (similar to when John McCarthy came up with the term “artificial intelligence” as a marketing ploy in 1956). Simply put, Virtual Reality exists at the human-machine interface. Many of us are now familiar with using the “window” (screen) as a way of looking into the computer generated world; the difference is that Virtual Reality strives to *immerse* the user in a computer-generated environment. Immersion is believed to enable the user to interact with both the computer-generated environment, and other users, more productively than they can do at present via the keyboard and mouse. Currently, computer-generated virtual environments fall short of the ones imagined by Gibson and his cyberdelic followers. The most advanced are those used in simulators for flying and driving. These are primarily training applications that have been developed by the military, though they have been massively adapted for the entertainment industry.

At the moment the credibility of the “virtually real” three dimensional space generated by the computer depends upon the sophistication of the system. The lower priced VR systems produce environments which consist of geometric shaped objects with pixelated edges. Even in the more costly configurations there is a lack of surface texture and high detail, and an absence of any believable representations of human figures (which are difficult and complex to “build” because of the morphic shapes which make up a complex anatomy).

Simulated movement through the virtual environments is directed by tracking the movement of the users head and adjusting the views displayed accordingly in goggles worn by the user. Sometimes a special glove hand allows the wearer’s gestures to direct movement through the VR space. Often the only visual

reference that the user has of the gloved hand consists of five crude cigar shaped fingers, with one fixed in a pointing action. Head movements are transcribed so that the computer can display in the goggles corresponding changes in the virtual environment, although these changes are often rough and jerky as it takes time for the computations to generate the new scene needed for each shift in view.

Away from the military arena, anyone keen to “virt out” at the moment needs to don a helmet (that old gender signifier) which has goggles bolted onto the front, and slide on a glove. By the time you get to wear them, these goggles, helmet and glove have been worn by countless other users on their cyberdelic trips; if there’s a flu epidemic amongst British VR fans this winter it may well be traced to the pedestals in Covent Garden, where you pay your money and get to stand on a raised platform, wearing all the gear (full of germs as it may be) “virting-out” to the crowd.

In her book Women in Computing Judith Morris (1989) proposes that the subject of computers can be unappealing to girls in schools because:

“much of the time allocated to using computers was left to playing games; nearly always combat games involving firing guns and shooting down spaceships, which were unattractive to girls.”

Morris (1989) p.1

The group “Organisation Against Sexism In Software” (OASIS) is primarily concerned with the

“sexist use of and marginalising of women and girls at the receiving end of the leisure software industry - that is as players of games, as characters within games, and as the objects used in advertising.”

Vogel (1991) p.20

Vogel focuses her article on the playing of computer games at home. This often involves the use of computers of the same brand as those used within schools, and computer games infiltrate education. There is little variety of plot in leisure software and the leisure software industry presumes that most of its users are male,

“and so churns out a barrage of software with muscular heroes rescuing planets, solar systems and women (and sometimes all three in the same game!)”

Vogel (1991) p.21

These plots account for about 90% of current software, while another 8% is dedicated to sports simulations and strategic war games. The remaining games are of the “test your IQ” type or pornographic strip poker games which nearly always feature women, not infrequently offering up images of well known models from pornographic magazines. It is estimated that up to 60% of the users of adventure games are women, in spite of the sexism and gender stereotyping inherent within them. It has been calculated that most games players are men aged 15-25 (adventure games are only one type of available game; war, combat and flight/driving simulation games are increasingly popular). But the way that the numbers of users is estimated is significant. The figures are taken from the results of questionnaires in computer user magazines. Questionnaires can only be filled out by one person, while many people may use the same software and read a single copy of the magazine. Computers and the magazines associated with them tend to be the property of males, but this does not mean that women do not have access to them (Vogel 1991). Women use their children’s computers secretly

while they are out, and as echoed in episodes of the Australian soap opera, “Neighbours” (Summer 1991), girls play computer games on machines belonging to fathers, male friends and boyfriends. But their involvement is less likely to be picked up through magazine questionnaires.

While it is not clear whether boys would opt for war games if given a choice (because there is no choice) there are indications that girls would be more interested in non-battle type simulations. The ways in which science and technology subjects are presented, with reference to the development of, for example, weaponry and the space programme, shows a disregard for the findings of MARPLAN and MORI polls. Both in America and here in the UK these polls show an increase in the gender gap with regard to disarmament (Davis, 1984). More women than men feel that the route to world peace is via disarmament. The association of technology with applications like those outlined above contributes to the belief that computers and the people that use them are part of a male culture. However, this stance invests in problematic universalisms about both men’s and women’s attitudes towards war games which border on the biologically determined. Janice Moulton’s “A Paradigm of Philosophy: The Adversary Method” in Garry and Pearsall (1992) makes an interesting case for the adversarial dispute as a masculine philosophical methodology based on a norm of behaviour considered inappropriate in women.

“It is frequently thought that there are attributes, or kinds of behaviour, that it is good for one sex to have and bad for the other sex to have. Aggression is a particularly interesting example of such an attribute.”

Moulton (1991) p.5

The male/aggression cultural nexus may be an important contributory factor in

the findings of the polls previously outlined.

Games that rely less on war strategies and masculine concerns are being developed. “Pak-Jana” is a dancer whose legs, arms and head can be choreographed by writing a simple program. It was developed at the Centre for Math Literacy at San Francisco State University to capitalise on the non-military interests of girls (Kreinberg and Stage, 1983). VNS, a group from Australia describing themselves as cyberfeminists have designed a game called All New Gen. The aim of the game is to subvert Big Daddy Mainframe (described as a Transplanetary Military Industrial Imperial Data Environment) by infecting it with a virus called Mist. All New Gen is a competitive subversive game rather than a passive non-violent game for women. VNS are currently negotiating a deal with SEGA (information from lecture by Sadie Plant 1993).

Unhelpful analogy (4): an ideological psychology of creativity

As Christine Battersby in Gender and Genius: Towards a Feminist Aesthetics (1989) has explored at length one analogy particularly unhelpful to women, the gendered mythology of “genius” through which men have historically claimed superiority over women in their capacity to produce any culture’s great works of the imagination. Dismissive views of the talents and potential of women have been, as many feminists have observed, systematically asserted in the androcentric history of ideas, which Sherwin (in Garry and Pearsall 1992) catalogues as a succession of works by leading historical figures “embarrassingly filled with powerful misogynist statements”.

One aspect of this is the history of ideas on human conception which has

consistently tended to see the male contribution as more technical (and more important, needing greater skill), reducing women to the role of a receiving vessel. This notion of men as the real “only begetters” extends beyond reproduction to other human activities like artistic creativity. The concomitant view that men are rational and active while women are emotional and passive has also coloured interpretations of human activity extending beyond sex to education, domestic activity and social life in general. Since women are associated with emotions, with nature and with the body, who would wish to entrust tasks to them demanding the higher reaches of rational judgement? The split involves a twin dichotomy between woman and man, between body and mind. In this view women are considered to be imbued with intuition, a trait held up as an atavistic “primitive” instinct which men’s higher state of evolution has superseded. As Jaggar (1992) states, “Within the western philosophical tradition, emotions usually have been considered as potentially or actually subversive of knowledge.”

The split between body and mind and the corresponding split between the sexes has been given credence by the plethora of male intellectuals and philosophers. This doctrine of separateness depicts woman as “stuck” within her body, prone to hysteria (hysteria itself derived from the Latin word for womb), unable to detach herself from preoccupation with her body (supported by the menstrual taboo) and childbearing. Woman is seen as a hypochondriac, weak and inferior in comparison to man who can spend his time in intellectual pursuits, detached from his body, which is considered of less import than the mind. Thus Charles Darwin (1871), paradigmatically a grand theorist, gave the following clearly essentialist account of the nature of women’s inferiority:

“It is generally admitted that with woman the powers of

intuition, of rapid perception, and perhaps of imitation, are more strongly marked than in man; but some, at least, of these faculties are characteristic of the lower races, and therefore of a lower state of civilisation.

The chief distinction in the intellectual powers of the two sexes is shown by man attaining to a higher eminence, in whatever he takes up..." (p.858)

Gendered theories of creativity, as Christine Battersby demonstrated, involve a startling paradox in that, particularly within the traditions of Romanticism, the virtually inevitably male genius is regarded as possessing an almost "female" intuition. From the mid-eighteen hundreds to the mid-nineteen hundreds, the predominant belief in Europe was that genius was the product of some psychological defect. All women were held to be degenerate, but (not surprisingly) female degeneracy was of a different brand and could not lead to genius.

In the early nineteen hundreds, Weininger's book Sex and Character "proved" that all geniuses were men. Although he acquiesced that all men and women had a degree of bisexuality, he also believed that men and women were not opposites; men could contain within them the female, whereas women could not achieve this androgyny. To be perfect, the woman had to be totally female. Therefore men could be complete - and hold the female within them, while women were destined only ever to be a part, unable to hold the male within their femininity. Only the complete could achieve the status of genius (Battersby, 1989). It seems contradictory that men such as Weininger should describe women authors and artists as "masculine", but this term is used as more of a rebuttal of such women's "unnatural" behaviour than any kind of acceptance that they might have characteristics of genius, for there is always the statement that no matter how much they looked like men, or behaved unlike women these female mavericks

could never be psychically masculine, never become genius. Christine Battersby (1989) charts the dismal consequences these doctrines have had for the woman with unusual talent aspiring to be recognised, and it is no surprise that one of the stronger feminist agendas surrounds the attempt to rehabilitate the silenced voices of achieving women.

Defining and controlling women's creativity

Gendered theories of creativity have in general restricted women's creativity to pro-creation, rearing children and homemaking, and men's to that of the hunter/gatherer and explorer. The 1920s saw the beginnings of female emancipation which threatened to erode the boundaries between the roles of men and women. The Women's Suffrage Movement prompted some severe reactions, one of the most extreme being Germany's 1920s Sex Reform Act. This act emphasised procreation and the family as worthy concerns for women, at the same time classifying as "unnatural" those women who deviated from a life of "kinder", "kuche", and "kirche" (Snitnow, 1984).

The art world, reflecting the position of women in society, largely excluded women, and as the subjects of men's art "unnatural looking" women were similarly ignored. The limp and contorted women of Rossetti, the Madonnas of the old masters and de Kooning's vicious images of whores; all show woman in the clichéd forms which predominate art made by men - as the virgin, the mother and the whore. The Futurists showed the automaton woman, depicting the male fantasy of the controllable mechanical woman that could be all three. The notion of woman as "under the control of men" has informed the representation of women in images which seek to assign value to new technologies; in Virtual

Reality women's images are contained and controlled by the technology as it is used by male practitioners (see Fig.16). By contrast the artist, Michelle Wardle sees the controlling aspects of the computer environment as a way of gaining a safe space for women to explore and produce images of themselves.

"I can't think of any artists - even dead ones - who have had any great impact on anything recently. Yet art schools continue to perpetuate the myth that genius will bring you fame and influence - you could be The One."

Kopper (1987) p.205

Divine power and inspiration are two of the terms used by Socrates to describe creative energy. He also argued that creativity could be the result of a kind of possession and inspiration, which in the Apology he calls genius. Socrates also saw creativity as emanating from a possession or madness induced by the Muses: an innocent (typically described as a "virgin soul") is taken over by a mania, promoting the creative madness which stimulates "good" poetry. By his omission of any references to women, it can be safely assumed that Socrates had men in mind.

Technobabble

An issue relevant to any discussion of gender and computer technology is the specialised vocabulary, *the jargon*, which has come to signify the realm of the computer. This technobabble is so strongly associated in the public imagination with the understanding of computers, it infers that if you can speak the lingo then you are adept at using computers. In short, and curiously, the jargon is taken to signify competence at actual hands-on control of the medium it describes. As Vannevar Bush (1945) prophetically put it,

“mechanisation may still force the issue, especially in the scientific field; whereupon scientific jargon would become still less intelligible to the layman.” p.104

What Bush envisaged actually came about, a machine which types when talked to - the automatic audio typist. But in so doing Bush also foreshadowed the current situation in which the jargon surrounding technological devices has become unintelligible to the uninitiated or those not in possession of a technical dictionary. Those iconised philosophers of the postmodern, Gilles Deleuze and Felix Guattari claim in On the Line (1983) that there is no longer any valid concept of mother-tongue, but that dominant languages seize power from within a political and linguistic multiplicity. The “language bulb” (to use their term) which has developed around computer technology has evolved rhizomally, spreading as computer scientists, programmers, hackers and enthusiasts have communicated via electronic mail, leaving messages on EMAIL notice boards.

There is a linguistic edge to the psychology of male bonding, and one of the functions of technobabble is to reinforce both community and authentic membership of it through a shared use of jargon. There are of course dangers, not least the assumption that if you can talk the lingo, you can be relied upon to be skilled in the use of the machine. Technobabble reinforces the status quo, the computer-speak elite know a lot of so-called “buzzwords”, and a liberal sprinkling of these buzzwords is necessary if you want to feel a part of the enclosed self-regarding world of (mainly male) “computer-nerds”.

The sexist language of the computer world extends even to the hackers, who purport to be on the anarchic edge of the technology. But however much they seek to cultivate a radical image, they are far from anti-establishment in their

language, which is permeated with euphemistic expressions and phrases revealing a coarse sensitivity. Susan Collins as recounted in “Redressing the Myth”, (1988) recognised an attempt at intimidation when she saw one during a visit to a computer shop in Tottenham Court Road where she encountered

“a keen (very), pushy, fast-talking, male (inevitably), sales assistant...*who* threw out words like ROMs, RAMs, bytes, megabytes, at such an alarming rate that one would be forgiven for feeling that there was a whole mountain of knowledge to be climbed before one could feel even halfway comfortable with the simplest of these machines”

In the realm of technobabble, recognisable words are recontextualised and their meaning drastically altered. “Mice” are no longer small rodents, but digital translators for hand movements. “Gender-bender” becomes the term for a cable which is attached to one kind of plug and which enables it to be connected to a different socket; sockets are “male” and “female”. The “hard” disc (frequently re-named “hard dick” by students) is more important, generically masculine and potent - more substantial than the impotent “floppy”, “soft” ware can be stolen and illegally copied more easily than “hard” ware. The use of terminology like “hard” and “soft” has been taken to imply a gendering of the machinery (Lloyd and Newell 1985) although the analysis might be felt by some to be too dependent on a kind of knee-jerk Freudianism. But the linguistic associations are real enough with the word “hard” associated with what is good, strong or difficult or overtly masculine (hard facts, hard-headed, hard science, hard-on, hardware) while “soft” can mean “easily malleable” as well as “effeminate” or “weak in muscle or mind” (see entry under “soft” in Chambers’ Twentieth Century Dictionary) and is associated with the feminine (soft touch, soft-soap, soft science, soft-spot, software). These “soft”, effeminate things are of less stature than the masculine hard ware, and yet remain consistent with the chauvinist view

- they are necessary if you actually want to do anything with your “hard” ware (Lloyd and Newell 1985). Quite literally, in order to run a program one has to put some software onto the hard disc. Andrea Nye in The Voice of the Serpent: French Feminism and the Philosophy of Language (in Garry and Pearsall 1992) poses an interesting question on the linguistic sexualising of the machine, linking it to a dark world of desire that lurks behind the rational:

“Is there in all language, even as it pretends to be most rational, a hidden writing of desire that expresses covertly sexual acts of desecration, penetration, fusion and desire? Is there at the very foundations of symbolic expression a passionate need transmuted to articulate demand?”

Nye (1992) p.236

The computer studio as a male domain.

The masculine aura which surrounds computing is not limited to the world of programming and hacking, but is just as likely to be in evidence when artists are using computers. In a recent talk at the ICA gallery in London, the animator Gareth Edwards spoke about his favourite pieces of computer animation. In his introduction he said he loved to give this type of lecture as it was a “great excuse to make “tarty” slides.” The slide he was referring to, of an electric blue ball with bit missing, seemed to many of us to be rather uninteresting and technique-driven. It was quite unclear what he meant by “tarty” (unless he intended some contrived pun on “ball-breaking”) and indeed whether the term was intended to be derogatory or not; but its use was certainly interesting. Edwards continued with a series of what he termed “jaw droppers”, a collection of computer animations and digital images that were technically exciting at the time they were made, but the piece he found most exciting was an American production widely known as Sexy Robot which featured a caricatured female physique in the style of an Allen

Jones' sculpture.

Possible strategies of amelioration

The next section considers a number of ameliorative strategies that have been attempted in Further and Higher Education. Some of these are considered in more detail in the cameo, the case studies and the action research.

Demystifying the technology

Much of the fear that people have for computers may be based on feelings of ignorance and a mistrust of that which cannot be controlled. Control depends upon an understanding of how to operate computers and how they work. These skills are denied to many people, especially women.

Nevertheless, the pliability of women is sometimes appropriated as a semiotic image of "friendliness" in the promotion and marketing of personal computers. It is assumed that people are afraid of new technology and the marketing strategies capitalise on this fear. Advertisements emphasise the "user-friendly" attributes of the personal computer, and Apple Macintosh in particular has made user-friendliness a central theme in the design and marketing of its computers. In emphasising the ability to control the machine easily, Macintosh also quietens the fear of the machine somehow "taking over" and becoming dominant, outside of our control. The famous 1984 advertisement for Macintosh represented a view of the world dominated by a less friendly computer, in which humans were engaged in repetitive mundane tasks in scenes heavily reminiscent of the film Metropolis. Then along came an athletic woman, with the power of the "friendly" and controllable Macintosh computer, to free the humans enslaved by Personal Computers and to defeat the "unfriendly" machine. This advert also bears witness

to the assumption that potential buyers for computer technology are science fiction fans, able to “read” the advert and susceptible to the science fiction fantasy it quotes.

Having women to teach in technology-based areas immediately erodes the mystery - there is living, teaching proof that women can use technology, and be good enough at it to adopt a position of authority about it. Whilst teaching on the Foundation Art course at Mid-Warwickshire College of Further Education, I experimented with a number of alternative strategies for demystifying technological practice. One technique is to explain all the abbreviated terms and to describe each function in everyday language, gradually introducing technological terms, and pointing out their inherent sexism where appropriate. At this stage having a laugh about the terminology undermines its alienating effect. Sheer repetition of functions and techniques is as important as the teaching of the thinking behind them. The demystification of technology for women is integral to empowering women:

“Combining the theoretical and practical ...courses try to dispel the mysteries and taboos surrounding areas from which women have been alienated and denied access, such as the technical and technological.”

Rothschild (1988) p.75

Desk top publishing usually requires the deployment of certain actions over and over, but these often consist of many stages. To learn these stages and to get them in the right order takes time; demonstrating a package is a good way to show its characteristics and potential but it inadvertently supports the notion of the teacher as expert, providing a competent role model. The technique of talking through a procedure with all the students doing it for themselves enables the inexperienced student to feel in control of the machine. I have noticed both from my own

process of learning how to use computers and programs and from teaching with them, that the learner has to ask the same question many times. A procedure is not necessarily repeated soon, so its form may be forgotten by the time it is needed again. This means that those students who are not embarrassed to ask questions get more out of the class.

One research conclusion that teachers seeking to promote equal gender opportunities should be deeply aware of is Spender's (1985) finding that male students claim more speaking time in mixed classes. This realisation calls for its own ameliorative tactics: in the first few sessions of a workshop I repeat the steps to basic functions as I walk around the studio and explain regularly that it is a natural part of using the machines to ask questions over and over until you are blue in the face! Making contact with the mysterious workings of the machine, by discussing its design and internal workings and how these affect the programs, gradually reveals it as a controllable and exciting medium, time-saving for word processing essays and useful for designing images.

Women-only classes

The possibility of women-only classes in technical areas of the curriculum is one response within a wider project that has been conducted recently with respect to gender issues in education, and the putative solution comes out of a sustained research-based analysis of the problems, as for example, in Michelle Stanworth's "Girls on the Margin: a Study of Gender Divisions in the Classroom" (in Weiner and Arnot Gender Under Scrutiny: New Inquiries in Education 1987)

Because of the ambivalent relationship that women currently have with technology in art and design education, both as staff and students, some colleges

have experimented with the feminist strategy of running women-only classes. These classes not only give educational opportunities to women to master [sic] the new technology in a protected environment, but also seek to address the sexist language associated with the technology by not allowing it to remain implicit. This direct confrontation of the androcentric aura that surrounds digital technology is likely for sometime to remain an issue of particular relevance to teaching in technology-based areas.

Women-only environments are an attempt to bypass the problems of those environments perceived as being “gendered” masculine. This approach is one response to notions of social difference and is usually adopted with the intention of increasing women’s confidence, opening up more speaking space than is available in mixed groups and giving women more attention in the classroom. Women-only work places are a manifestation of “social difference theory” strategies described by Ann Ferguson (1992) in “A Feminist Aspect Theory of Self” as “radical feminist”,

“the strategies of radical feminists, [on how best individual women can reclaim a personal power denied by the standards of femininity, are] in favour of a collective process in which women bond with other women to re-value feminine work and values, thus allowing women’s self, based as it is on the worth of the feminine itself, to gain power.”

Ferguson in Garry and Pearsall (eds) p.99

These environments provide a forum in which women can “find their voices” by offering them more opportunity to do so. The adoption of women-only spaces can be traced to the popular consciousness-raising groups of the 1960s. While theorists seeking to define a broad feminist epistemology, like MacKinnon (1983), rest their case on a view of feminist methodology as “consciousness

raising”, others engaged in the same kind of project, such as Sherwin (1991) are uncomfortable with it as a method. Sherwin voices a “deep ambivalence” about it, and questions whether it is an “acceptable philosophical methodology ” at all. The problem with adopting the strongest versions of “feminist standpoint theory” is that at worst it could be seeking to establish a discourse in which the male voice becomes the excluded and silenced one. Elspeth Probyn in “Travels in the Postmodern: Making Sense of the Local” (1990), treats this as a problem of “location”, associated with placing women’s experience at the centre, drawing attention to a critical question now facing feminism and Western thought,

“[I]n creating our own centres and our own locals, we tend to forget that our centres displace others into the peripheries of our making.” (p.176)

This articulates one of the accusations often made when women-only courses are proposed, that they are simply a form of reverse sex-discrimination. This presupposes that women and men function identically, treat each other equally when in mixed-sex groups and that men and women have similar reasons for wanting single-sex environments. This supposition ignores the history of men-only spaces such as clubs, union meetings and pubs etc., where men systematically exclude women from activities and places because they feel women are inferior. Women-only activities, on the other hand, often exclude men as a means of creating opportunities for women to learn and express; not because men are considered inferior, but because of the perceived male dominance in mixed environments.

The provision of spaces within mixed schools and colleges for “girls-only” is becoming more common as an educational strategy. Responses to this are varied and are similar to those invoked by proposals for women-only classes. The accusation that a women-only space is sexist can pressurise girls, who are initially

keen on such an environment, to change their minds. Alternately, the spontaneous creation of women-only spaces by women staff in authority, such as head mistresses, without broad consultation can be either well received, or misinterpreted. A compromise seems like the best approach. When girls have a formalised arena for making such a request, like a school council, the whole issue can be carefully integrated, with full consultation with staff and considerable preparation via talking it over in tutorial groups. This matter has been analysed recently by Pat Mahony in "Sexual Violence and Mixed Schools" (1989). As she indicates, girls will reject single sex classes where they interpret them as a response to the attitude that girls,

"need something special in order to help them cope with or be as good as boys ...where the problem is defined as male behaviour, girls response [to single sex classes] is positive."
Mahoney in C Jones and P Mahony Learning Our Lines (1989)p.181

Let us for a while follow Mahony's argument. Her data confirms the sense of relief that female students can gain from working in single sex groups. This can be inferred from an interview with a 12 year old student, who in spite of feeling that the teacher has failed, remains keen on the subjects that were brought up, and sees the removal of the boys and the creation of a girls-only lesson as a positive solution:

" 'We had a student last term; she was really nice. She saw a lot of things that weren't fair in our class but she didn't make you feel like it was your fault. She understood our problems. She knew a lot about things women had done, things you'd never dream of. She never got a chance though, some of the boys were awful to her. I got to hate her lessons because she couldn't control us. I think she should have expelled the boys, the rest of us wanted to work, her work was interesting. But she wasn't a good teacher.' " p.168

If there is no formally structured women-only space then girls will often create pockets of single sex space within mixed groups. Mahony recounts an instance where she overheard girls in a science lesson, explaining why they worked separately from the boys,

Karen: “Well tell her Miss, she keeps saying we’re sexist because we won’t work with the boys.’

Pat Mahony: “Why won’t you?”

Karen: “They keep messing up the experiment and we can’t get a turn on the microscope. They think they’re the only ones that can do it. Will you tell her?” ” p.166

Teaching about women and technology

Women’s Studies courses started in the late 1960’s and ten years later teaching about women and technology began. In her book Teaching Technology from a Feminist Perspective, (1988) Joan Rothschild describes and analyses the way that feminist perspectives on technology have affected the teaching of technology in the college classroom. She claims that feminist perspectives bring holistic approaches to knowledge and that these approaches are based upon women’s personal experiences. Such approaches aim to go beyond the common subject-object split of traditional Western scholarship and reverberate with the underlying themes of this thesis - that understanding and learning is in part experiential and embedded in the inter-connections between subjects; that drawing attention to connections between seemingly diverse themes and discussing and researching these connections is a powerful way of making sense of the world. In Australian Aboriginal culture everything in the world is connected; each animal and mark on the landscape, each piece of machinery has been sung into existence by the Ancestors as they walked across the land, so that in one sense new inventions have always been there, just waiting to be discovered. Traditionally, Aboriginal children learn by having their connection to the land, animals and objects made

clear to them, each new item described to them by their parents who encourage them to explore, to connect with the world around them. Women's Studies courses do a similar thing, as a response to the feminist observation encapsulated by Sherwin (1992) "that the work of the leading historical figures is embarrassingly filled with powerful misogynist statements." Retracing history, and connecting with women from the past, enables women to make a new and more informed sense of themselves and the world.

WOMEN ARTISTS AND VIDEO PRODUCTION AS ACTION RESEARCH

Hopefully, by building on the previous chapter's attempt to map the ambiguities and contradictions faced by women in technological environments, this chapter now moves on to consider explicitly the role of women artists.

The first section deals with a concerted recent attempt by women to subvert the genre of androcentric science fiction, in doing so getting close to establishing a women's science fiction as an alternative genre. I use the term "genre" in standard reference to its use in genre-theory in suggesting that there are stable audience expectations and responses to the narrative and normative conventions deployed, although in passing science fiction (like the Western film) is a genre in permanent danger of collapsing into self-parody. The methods employed in this section are largely those of literary criticism and cultural deconstruction, and the section begins with a brief account of the male science fiction and VR fantasies that the women are reacting against.

The second section is based entirely on my own work as a video artist using digital technology, examining the consequences of practices and performances undertaken on both sides of the camera lens, in mixed sex video shoot in a television studio. As indicated in the methodological chapter, this was perceived as a form of action research, seeking not only to further group and individual understanding by reflecting on the exercise but also to take the lessons back, both to a rethink of what institutional arrangements should govern the video studio, and also to create a feedback loop in my own artistic development. In some respects this use of action research was unable to take advantage of some of its claimed strengths, whilst making its well-known weaknesses particularly potent. These issues are dealt with below, but I feel comfortable with the outcomes within these limitations. It is also worth mentioning that I was able to leave the

tape recording for the period immediately following the shoot in the studio, and this became an important source of ethnographic data both in the observation of the behaviour of the participants and in recording initial comments. Both have been reexamined in producing this account.

Androcentric science fiction and male virtual fantasies

Authors like the science fiction writer William Gibson are typical in having appropriated the technobabble jargon and sprinkled it liberally through their novels, where it gives a realistic feel to their stories of techno-whiz-kid characters living in future worlds crammed full of technological items to which society seems to be addicted. Technobabble has an aura of power; it imbues futuristic novels with an air of authenticity, which is reinforced by the element of mystery offered by the use of abbreviation. There is a currency of contemporaneity implied by the mimicking of street-wise lingo, monosyllabic words and alliteration.

Unsurprisingly, William Gibson has collaborated with the 1960's psychedelia icon Timothy Leary, who has now abandoned drugs for what sounds dangerously like a parallel cyberdelic fantasy, a belief that the future mental adventurers will be able to "jack" into a networked computer and access the virtually real inside their own brains. Leary and Gibson have collaborated in the making of a computer based, interactive version of Gibson's best-selling science fiction novel Neuromancer (1984).

In the book, Gibson's "virtual reality" does not include graphic simulations of users, but relies on more abstract shifts in visual perception. One of Gibson's characters, travelling in virtual space, experiences sensations of movement as

bands of changing colours, geometric shapes and patterns. His image of the future builds on the video arcade but the boundary between the person and the technology has collapsed even further:

“Behind the counter a boy with a shaven head stared vacantly into space, a dozen spikes protruding from the socket behind his ear. ...His hand hovered, selected a glossy black chip that was slightly longer than the rest, and inserted it smoothly into his head.” (p.74)

In an imagery reflecting the drug culture, Gibson’s characters call their programs “Mainline” and “jack” into a central computer via small “dermatrodes” stuck onto their temples or by sliding silicon chips into slots in their heads (Gibson, 1984, p.78).

Male science fiction does include women although increasingly, with splendid irony, as creatures to be feared. In the nineteenth century, men feared women’s difference; in the twentieth century men’s fear is that we are the same (Bellour, 1978). The depiction of cyborgs in science fiction film may be responding to this fear of sameness by reinforcing sexual difference, countering the male fear of the New Woman, the androgyne with short hair, athletic build and fulfilled ambition and attempts to halt a blurring of gender that is in danger of becoming too threatening. Ripley, the female commander in *Alien*, dons the expeditor, a robot-like machine that is operated from within, and which the pilot “wears” like a huge mechanical overall. With her strength augmented by the expeditor, and her skills as a strategist, she succeeds in destroying the mother alien, considered by some feminist critics to symbolise the monstrously feminine (Creed, 1990). In the final *Alien* film Ripley’s sex is indirectly the cause of her suicide - she is impregnated by the alien and sacrifices herself rather than carry its offspring.

If voice simulation attaches gender to the machine, then the possibility for cybersex sexualises the machine. VR has, through media and industrial hype, succeeded in exciting the imagination of so many people (both the ecstasies and the technophobes). Subsequently its musings on possible addictive qualities and its potential application to sexual experiences have both kept the hype from dying down and aroused a fervent debate. In computer studios, pubs and clubs, at parties and in lectures the subject of “cybersex” is frequently and enthusiastically discussed. Cybersex or “teledildonics”, to use one of Ted Nelson’s terms in Literary Machines (1987), refers to having a virtual sexual experience with another person. Any realisation of cybersex is likely to employ Virtual Reality systems that translate code carried by telecommunication systems to physical sensation via a suit lined with sensor pads. At the moment, items like the glove used in some VR set ups relay the sensation of weight and crude touch. If the wearer “picks up” an object from the graphic representation of the virtual environment that they are moving through, then sensors on the glove can push into the hand, relaying the feel of the object. As Rheingold’s Virtual Reality promises,

“...your representations are able to touch each other, even though your physical bodies might be continents apart. You will whisper in your partner’s ear, feel your partner’s breath on your neck. You run your hand over your partner’s clavicle, and 6000 miles away, an array of effectors are triggered, in just the right frequency, to convey the touch exactly the way you wish it to be conveyed.”

Rheingold (1991) p.346

The current cybersexual fantasy is the strangely limited one of having a remote sexual experience with a person, or persons, who could be anywhere in the world, rather than of having sex with a dream-lover machine that can pass the Turing test. Cybersex may provide us with a means of escape from the present, offering

an experience which precludes direct contact and supports the act of fantasising. Although it is stressed in the writings on the possibilities for cybersex that it is not sex with a machine, but via a machine with a remote human partner, it does not require a huge leap in imagination to see that as machines are programmable the input could be as readily accessed from stored data as from another machine connected to a remote partner.

By all accounts the technology needed to create a half-way convincing cybersexual experience is still a long way off. Apart from the sophisticated yet encumbering body-stocking that would be required, with its hundreds of built-in sensors, the exchange of information from these sensors would require computer processing power and fibre-optical links to transmit it which are currently out of reach. The body-stocking is probably the first element of this set up that we will see. There is a crude version in development now (Rheingold 1991) which is surprisingly thin (it has a skin-like depth). There is considerably less talk of high technology's mundane applications (such as VR massaging patients with cystic fibrosis) except, as Donna Haraway ironically notes (citing Vic Sussman's 1986 Washington Post article "Personal Technology Lends a Hand") when the public relations agenda is to give militarised high technology a benign face. Her acid comment is worth quoting in full:

"the convention of ideological taming militarised high technology by publicising its applications to speech and motion problems of the disabled/differently abled takes on a special irony in monotheistic, patriarchal and frequently anti-Semitic culture when computer generated speech allows a boy with no voice to chant the Haftorah at his bar mitzvah."

Haraway (1990) p.233

In the meantime the cybersexual fantasy partner is increasingly portrayed as the stereotypical California beach “chick”, long legged, curvaceous and above all digitally predictable. The virtual sex depicted in the film Lawnmower Man involves just this cliched representation of woman (see Fig. 17). For those yearning for a technical footnote, the Lawnmower Man cyber-doll was produced as animation sequences by computers with vast processing power over a period of time which facilitated the long time it took to render each frame. Current graphics available to respond with visuals that move in real time restrict visual representation to the very basic (see Figs. 16 and 18).

Feminist ambivalence towards new techniques

Although repeating that “women” in this thesis are never treated as an essentialist category - and indeed one of the fundamental agendas of feminism, properly understood, is to deconstruct gender as an essential category - groups of women artists have from time to time acted on some implicit manifesto with respect to the issue of artistic representation and available technology, and their position has tended to be cautious and ambivalent. As ever these matters can only be sensibly discussed in local contexts.

In the mid 1980s when there was a strong Modernist movement towards the use of visual effects in art video, many women deliberately chose not to use these techniques, or to use them sparingly, and there was a distinct impression that in all too many cases the effects were used because they were there, and for that reason alone. The aggregate result was a diet of repetitious and predictable video images, each colourised, solarised, strobed, mirrored or given coloured trails. By contrast many women artists using video made pieces which dealt less with the “material” of videotape and more with their experiences. For many of these

practitioners their subject matter was figurative rather than Modernist. this can be interpreted in different ways and could be seen as an example of postmodern diversity as summarised by Garry and Pearsall (1992) “The postmodern project of “deconstruction” erodes claims of universality, replacing them with multiple historically rooted, fragmented, flexible, and diverse discourses.” Alternatively the same divergence of practice could be viewed as women artists acting within a historically changing environment and deliberately reflecting the changes back to the dominant culture. Smith (1989) describes this strategy which uses the individual’s experience of the world as “a source of concerns, information and understandings of the actualities of the social world”

More recently the computer animations of Maria Jimenez and Claudia Frutiger have provided witty and cutting examples of video art produced by women which does not rely on the macho subculture that has rapidly grown around these technologies as a result of them being fetishised by male users, but instead manages to confront myth and gender through a magazine style of computer animation (see fig 19). Not least because Maria and Claudia are ex-students of the college, I used their work in a module studying representation, myth and stereotype as part of a practical and theoretical media course, the BA in Contemporary Media Practice at the University of Westminster. The kind of teaching designed to subvert a gendered view of technology can also elicit fiction as cultural data. In particular, I have been able to use Joan Slonczewski’s A Door into Ocean in a consideration of how women’s science fiction writing can be used as a vehicle for exploring possible future non-alienating roles for women in a technological future.

One interesting theme in women’s science fiction is to explore the possibility of a

utopian matriarchal society in which science and technology are rescued from male abuse, technology generally has an important part in the structure of these novels. Where science fiction written by male authors emphasises the abuse of technology by people of both sexes, science fiction written by women largely presupposes that it is a male abuse. A matriarchal utopia is imagined in A Door into Ocean, with its feminist emphasis on collective values and decisions rather than the macho individualism of male science fiction writing. Her women's laboratories are more advanced than those of the men and facilitate sophisticated genetic engineering, using organic instruments. Living vines cocoon and heal mutilated bodies, allowing severed limbs to regenerate. The writer re-invents technology in a challenging way, decentralising the technical facilities and inseparably interweaving technological advance with moral and ecological considerations. In Slonczewski's future world, there is an open sharing of technical knowledge and all actions are debated planet-wide in open forums. What seems to be revealed is a feminine desire that goes beyond poetry and hysteria (Nye 1992) and which conforms to what Nye describes as "a feminine "textual" practice [which] is truly feminist and not a return of women to the impotent marginality of poetry and hysteria."

In A Door into Ocean, technology-as-we-know-it is in the hands of men from the mixed planet Valedon (Earth?). Their alienating technology is used against the Sharers (the female populace of the ocean moon Shora) who are considered alien by the Valedons. Highly technical weaponry is used by the colonising Valedons to kill the women while poisons and oils pollute the seas. By contrast, the Sharer women will not use their technologies in applications that would destroy or control other life forms (even those life forms which cause death to the Sharers) or destroy food supplies and homes. Not surprisingly, this book has been

described as a study of non-violence, strongly allying women with nature and an alternative, or appropriate, technology. Though they are deeply connected to nature, the women of Shora do not reject technology outright but develop an alternative technology and apply it differently. Although a feminist postmodernist could well find the narrative naive and ahistorical, and the gender theory essentialist, there is no doubt, as Sally Miller Gearhart (1983) writes, that in this kind of women's science fiction technology is allied to nature and the emotions rather than reason and the technologically rampant, with women "holding a "same" rather than "other" relationship to nature".

As A Door into Ocean progresses, an oppositional view of technological practice is portrayed. The patriarchal Valedon ways are contrasted to the utopian matriarchy of Shora, but ultimately there is a postfeminist reconciliation as the missionary zeal of a Sharer woman converts a Valedon man to the new ideological purities. The introduction of this central male character in Slonczewski's book may be a symbolic reflection of changes in feminist culture which have resulted in an increasing tolerance towards non-separatist feminist groups.

It may be useful at this point to recall the argument put forward by Jane Spencer (1986) in The Rise of the Woman Novelist: from Aphra Behn to Jane Austen. Ms Spencer's historical account of the entry of women into fiction writing was that it occurred at the time when the public life/private life separation was at its most secure, and she writes as if the genre were permitted only on the basis that women would confine their attention to the domestic and the moral, producing what were in effect "code of behaviour" books. At the same time, the unholy alliance between Capitalism and Protestantism was promoting the spiritual diary (John

Bunyan's Grace Abounding being one of the best known) on the view that the "examined life" was the one obligation shared by pilgrims and entrepreneurs. At worst, the feminist insistence that the personal is the political can be read as the mere continuation of this tradition, with women's writing irreducibly trapped in the domestic.

Lesley Saunders' Glancing Fires: an Investigation into Women's Creativity (1987) sees things differently, viewing them as trapped by patriarchal society into an "economic marginalisation" which leads them in the direction of "confessional writing" aimed at an audience of like-minded sufferers. One recent strong historical influence has been the women's Consciousness Raising group and the view that women can be transformed by "truthfully" exposing the details and contradictions of their experience.

Transcending domestic environments with technology

In principle, digital technology is capable of dissolving the walls of the domestic prison and women artists familiar with the new technologies have been able to establish an interesting niche for themselves. If as Roy Ascott asserted in the speculative remarks he made at the Sheffield Media Show, No Simple Matter: the Artist as Media Producer in a Universe of Complex Systems (see Ascott 1992) art is to die a complex death, to be transformed into experience and interaction which takes place between telepresences in the datasphere, then the icon of the artist-in-the-garret or the mother-stuck-at-home will lose its signification. Already women are using this technology to their advantage: a good example can be found in the singer/songwriter Buffy Saint Marie. In the Spring of 1992, during an interview on TV AM she described her working process; she has a extensive Macintosh computer set up at her home, she sings, plays guitar, drums etc. into her computer

via a microphone and tries things out using the sound editing software. All this information is sent via a modem along phone lines to the recording studio where it is recorded straight onto tape. Her most recent album has been produced this way, enabling her to create her music while being based at home.

There are some creative areas, including computer-imaging and videomaking, which require relatively expensive equipment such that, given the economic marginalisation of women, individual participation from some domestic setting in the global village is financially unlikely. One promising answer has been the provision of community based computer-imaging facilities such as those supplied by Artec, funded by Islington Council, which also prioritises those who have been unemployed for six months or so. Artec has a wide range of Macintosh equipment capable of animation, colour imaging and multimedia as well as sound studios and video edit suites. Tuition is by experienced and well-qualified staff from both art, design and industrial backgrounds. Not surprisingly their courses are vastly over-subscribed. When I spoke to the director of Art Tech he told me of their plans to create an exhibition space for art works made with computers and video, when it comes to fruition this will fulfil a need for this type of space and promote installation and multimedia works.

Women's ambivalence towards the technology

Women artists often exhibit a particular ambivalence towards technology, which is widely seen as having a special resonance for women, with an emotional history that has included confrontation with the war machines at Greenham Common, anxiety about the effect of VDU screen emissions on foetal development and the prevalence of repetitive strain injury among keyboard

operators. Certainly aspects of the technology available to artists are widely perceived as being culturally contaminated, from anti-militarist, anti-sexist and pro-environmentalist perspectives. These matters virtually preoccupied the one day discussion organised by the Museum of Modern Art, Oxford in 1990 as part of a ten year retrospective called Signs of the Times. Add to this the capacity of computers to store, and cross refer, data gathered from many aspects of people's lives, the use of video as a tool of surveillance and the discomfort women artists associate with using new technology is easy to comprehend. What stops artists from simply walking away from these technologies? My own inner-conflict seems typical and has been reiterated by a large number of the artists I have spoken to, and was vocalised at the discussion at MOMA. Yet overall I find myself clinging optimistically to the belief that the technology is not intrinsically good or evil.

With most artforms going through an anti-illusionist phase (witness the insistence of the theatre and television studio on displaying rather than concealing their own technical apparatus), it is scarcely surprising, given the ambivalence referred to above that much of the art made with new technologies refers overtly to the tools used in its creation. Nam June Paik builds pseudo-robots with video monitors: Susan Hiller's An Entertainment keeps the viewer aware of the projectors as images move in and out of focus and as image resolution reflects images from different media sources. Margeret Benyon (1982) uses technology to refer to technology, "drawing attention to the dangers of nuclear war". Nonetheless, it is not difficult to see her holograms, as Catherine Peake does in LIP Feminist Magazine (1980) as not substantially detached from "the basic spatial propositions of flat canvas".

I have come to believe that it is too simplistic and unrepresentative to seek to make sweeping generalisations about women's approaches to producing artworks with technology, even though some tentative situationally-grounded assertions have been attempted. It is obvious that many of these issues are questions on which women themselves take different positions. I now turn to a small, highly specific area of work in which I was myself directly involved as a video artist working on the outer edge of imaging technology. The example concerns the production of mediated images involving female nudity. The following account is seen both as a case study and as a particular, perhaps slightly unusual, form of action research.

Video production and action research

As indicated earlier in the chapter *The Methodological Matrix*, the thesis acknowledges its debt to a number of inquiry modes, some of which have been deployed precisely, others of which have been deployed more approximately as inspirations. Mentioned among the methods were educational ethnography, participant observation and action research, which are not seen as pure categories but to some extent overlapping. The claim that this section of the thesis is a form of action research is the most tenuous, and it is necessary to qualify the assertion even as one is making it. Nevitt Sanford's A Model for Action Research (in Reason and Rowan 1981) broadly guided the view taken of action research, particularly his view that it is analysis that determines what kind of questions are to be asked and his assertion that the basic question will always be how to "arrange the environment, institution or the social setting in such a way as to promote the development of all the individuals concerned". I must acknowledge at this point that there is a sense in which this individualistic agenda was particularly important to me in relation to my work as a video artist, although the

research was clearly collaborative in developing with colleagues within an institution, ways of handling particular practical and pedagogical issues in studio settings. The research was also undertaken in collaboration with a wider network of stakeholders, such as feminists in education, who were seeking to explore across settings, certain focused issues concerned with body representations in video and media studies. This may be taken to imply, correctly, that the “collaborative” aspects of the research were “bounded” in two ways (see Adelman et al, 1980) as the findings were fed back to two quite distinct interest groups.

The work of John Elliott (see 1985, 1987 and 1991) is more difficult to map onto because the tradition he has been developing has characteristics in common with my work, but some features it would be dishonest to lay claim to. At heart, Elliott’s version of action research came out of the tradition of “teachers as researchers” that Lawrence Stenhouse first mooted in relation to the Humanities Curriculum Project (see Stenhouse 1975). As described by Elliott, the tradition repudiated the kind of curriculum development which “appealed to teachers as rational adopters”, instead proposing “principles of procedure” in relation to which the teachers were viewed as “pragmatic sceptics” (Elliott in Michael Dunkin ed. 1987). My problem with Elliott is not his general endorsement of a classroom ethnography, but two features of his work that take it in a direction away from my own. Firstly his dependence on a so-called “logical analysis” of “teachers’ own concepts” to produce the “pedagogical principles” that the research is intended to investigate, and secondly, the nature of the institutional collaboration envisaged, which it is difficult to separate from group-wide curriculum or pedagogical reform. Although there was an increasing tendency to give teachers “greater responsibility for theory generation”, particularly in his

work with Ebbutt on the Schools Council TIQL Project and the resulting Classroom Action Research Network (CARN), the exercise tended to remain at the level of an implicit practitioners' theory made implicit rather than a testing of critical theories generated outside of education. From the standpoint of this thesis, the extension of action research to contribute to a critical theory of society is necessary in order to handle issues related to patriarchal oppression. In that respect Grundy and Kemmis's Educational Action Research In Australia: the State of the Art (1981) seems a more compelling inspiration, although their practical interests in emancipation are oddly silent concerning the emancipation of women.

A more recent book edited by William Foote Whyte (1991) on Participatory Action Research was not particularly useful in my context as almost all the examples dealt with sustained democratic efforts in a variety of industrial or commercial contexts to gain productive or organisational advantage over rivals, conducted within timescales that bear no comparison with my limited efforts. I was, however, attracted to the analysis offered by Chris Argyris and Donald Schon in the chapter "Participatory Action Research and Action Since Compared". They argue that there is "a fundamental choice that hinges on a dilemma of rigor or relevance" and that "from the action researcher's perspective, the challenge is to define and meet standards of appropriate rigor without sacrificing relevance". They stress the usability of findings, which is important to me since I see the whole exercise as a part of feminist praxis, but they also seek "an appropriate methodology of causal inference" whereas this study working as it is in a complex cultural nexus, does not share the preoccupation of interventive action research in commercial environments with demonstrable cause and effect.

To summarise these initial complexities, the claim of this section of the thesis to be action research largely surrounds two propositions: that the participant observer undertook a programme of collaborative investigation, as director of a video crew, in order to explore and improve practical arrangements in one area of the departments work; and also placed this particular shoot in a sequence that allowed her to feed it back into her development as a video artist. Within the complexities of the setting, both agendas tended to fall within Clifford Geertz's description of the intellectual effort that goes into anthropology as being very much a matter of "thick description" (see Geertz 1973). Although I will be unable to match the thickest of Geertz's famous thick descriptions ("practicing a burlesque of a friend faking a wink to deceive an innocent into thinking a conspiracy is in motion"), his view that ethnography exists to exhume "a stratified hierarchy of meaningful structures" is an attractive one, and I am very aware that the gendered world of the mixed-sex video shoot is an extremely complicated one. Geertz makes the point nicely:

"In finished anthropological writing ...what we call our data are really our own constructions of other people's constructions of what they and their compatriots are up to -is obscured because most of what we need to comprehend of a particular event, ritual, custom, idea, or whatever is insinuated as background information before the thing itself is directly examined."

It will be obvious from this account that the "learning from action" agenda rises out of and is imposed upon normal ethnographic research techniques in education, including participant observation. Harry Wolcott's "Ethnographic Research in Education" in Richard Jaegar's Complementary Methods for Research in Education (1988) offers salutary warnings about both, seeing ethnography as socially significant only in its ability to discern "how ordinary

people in particular settings make sense of their everyday lives” and demanding that participant observers should offer a full description of the precarious nexus that exists between participation and observation. I will try to observe both strictures.

In the descriptive and interpretive accounts that follow my own role as participant observer and action researcher concealed a double thrust, involving contributions to “collaborative learning” both within an institutional setting (in which the physical arrangements for the video shoot “bounded the case” (and also within a loosely structured women-in-media group, in relation to which the shoot was just one situation through which we were looking for cross-site generalisations). I did not feel it was particularly necessary to spell out this double agenda, although it may have resulted in what Colin Bell’s “A Note on Participant Observation” (1969) called “a performance break”, which occurs when a researcher working overtly also plays a covert role.

The events which became the focus of this participant observation and action research surround my work as a video artist. Both were in relation to pieces of work dealing with one of the persistent themes that have also occupied me as a media practice teacher, attributes of the female body and the significant structures of signification that surround it. The first was the video To Be Born Through Our Own Hands which attempted to reveal an internal reality by projecting it as if it were a quasi-gynecological event, suggesting that women’s experience of redefining their own bodies might enlist the metaphor of rebirth through self-discovery.

Video sequence (1): To Be Born Through Our Own Hands

Although the projected video was expected to have a running time of approximately seven minutes, the studio had been booked for a full day. This kind of ratio is normal, especially in a non-professional environment, and was needed in order to cater for the technical setting up of the camera and lighting and for repeat takes. When I arrived at the studio, which was a specialist facility within the Fine Art Department of the then Sheffield City Polytechnic, I was already fairly clear about the sequence of shots, although my ideas were rather better worked out in some areas than in others. For reasons that will become clear later, I was both directing the shoot and its only subject, an ambivalent double responsibility that in effect placed me on both sides of the camera. I expected the nakedness that the shots required not to be associated on this occasion with subjective feelings of vulnerability, since I was working with a women-only crew. The first shot we set up was the a close-up of my stomach moving rhythmically under breathing, framing from hip bone level to just below the breast. To get this shot to work without clothes was easier than to rearrange them to avoid getting them in shot. There was then to be a cut to a profile shot with similar framing but with strong yogic associations, after which the rhythmic visuals drifted strangely out of sync with the breathing on the soundtrack. Next head and shoulders were to enter the frame from the top (see Fig. 20), allowing the arms and hands to form a pelvic shape that then crowned the head, in clear reference to the metaphor of parturition. This shot was to be intercut with choreographed muscle-flexing gestures reminiscent of body building, through which my head was seeking to dive, adding androgynous associations of female athleticism to the birth imagery, implying a kind of feminist triumph over biological determinism. The crowning of the head was intended to be read as symptomatic of both the erotic and the ethical drive; and in spite of the element of self-regard, the signifiers of empowerment (muscle-tone etc. and the title of the piece itself) reject the imagery

of subjection and passivity that is so often attached to women. Giving birth to themselves rather than others, women became free.

In retrospect the theme appears dated, almost teetering on the edge of narcissism, but the contextual difficulties in attempting it at the time were enormous. It felt very strange to disrobe in the studio, although oddly more so in the presence of the technology which seemed to me to signify masculinity with the camera standing in as a kind of surrogate male gaze, much in the manner theorised by Donna Haraway (1990) who sees “technologies of visualisation as recalling the important cultural practice of hunting with the camera and the deeply predatory nature of photographic consciousness”, an account reminiscent of the even more sour account of the medium offered by Sontag (1977). It crossed my mind that although we had advised the (male) technician that he was not needed for this particular shoot, he might still arrive in another capacity, to check on equipment, generally tidy up or simply lurk. In the event he satisfied his professional conscience by hovering uneasily just outside the door, which one of the women had locked as a courteous response to what she read as my slight fraughtness.

We began to work and I told the crew how nervous I felt, although as it was new to them too they were unable to project themselves as competence models in the unfamiliar environment. I felt that their reassuring comments were personal rather than professional, and I only lost my self-consciousness when we worked out the framing for each shot. I soon relaxed and we took our time, trying out different shots, until the piece was completed to my satisfaction.

At the end of the planned shoot, a unexpected playful quality took over as the women crewmembers suddenly dissolved all the roles and engaged in an implicit

whimsical critique of camera-directed behaviour by hamming up some of its more clichéd performances. Mary got in front of the camera where she put on exaggerated faces and gestures whilst Sandra experimented with alternative framing. Soon they were parodying celebrities, setting up mock newsrooms and mimicking the dolefulness of film-noire. During this playful experimentation Mary admitted to the temptation that she felt to pout and eyelash batt at the camera, while Sandra kept repeating solemnly the tongue-in-cheek order, “Make love to the camera”. Both admitted narcissistic pleasure in seeing their image on a facing monitor, although finding it spatially dislocating. Mary tried subtle changes to her facial expressions, making a pout become mocking rather than suppliant and finishing with a definite sneer. She was quite unable to produce a steady gaze.

What is one to make of all this? My own view, which all three women confirmed, was that this sequence (which gained its ironic edge from being actually shot on spare tape rather than mocked-up) ended up just as valid an exploration of women’s self-discovery in the context of media as my own, and perhaps in one area - deconstructing women’s experience at either side of the lens - even more insightful in its spontaneous comedy than my own rather serious-minded photographic essay. We agreed that collectively we had learnt a lot.

Although the above account is rather obviously an account of playfulness, I am attracted by considering the notion of the “game” (in contrast to “play”) as a useful metaphor for reflecting on the process of group work. This insight has a long history, for example in the work of George Herbert Mead (1934) and more recently in Erving Goffman (1959). For Mead, playing incorporates ritual and taking on the roles of key figures, whilst participating in a game requires an

understanding of all the other players. For Goffman, social life is seen as a kind of on-going game in which the actors are constantly defending their “definitions of the situation” through a tactical interaction based on the metaphor that everyday life is street theatre (see The Presentation of Self in Everyday Life 1959). Both of these insights are part of the “theory” through which I am attempting to deconstruct the life of the video studio.

Working with the women I felt able to experiment with the camera angles and poses, and could risk attempting unusually angled shots or body images that would be unlikely to reach the final edit. Certain shots such as low camera angles carry graphic associations with the visual clichés of soft porn, and I found myself less prone to culturally-rooted self censorship when working with an all woman crew.

Video sequence (2): Sequitur

The second video sequence through which a practical exploration of these issues became possible was the breast-beating sequence in Sequitur. Once again it would be misleading to claim that these shots were contemplated merely because they provided an opportunity to revisit the female body question in the context of a mixed crew - I would claim that the selection of the episode was thematically justified and not just a piece of ethnomethodology - nevertheless in part I looked forward to the event as a behavioural study.

Some initial setting of the scene is required here, both physically and artistically. The locale for the production of the Sequitur video (see Fig. 21) was the television studio in the Department of Media at Coventry Polytechnic, now the University of Coventry. Since Malcolm Partlett’s work at MIT, (see “Two

Experimental Programmes at MIT”, in David Hamilton et al Beyond the Numbers Game), curriculum evaluators working in the “illuminative” tradition have paid greater attention to what he called “milieux studies”, and this notion is important here.

The studio in question had a recent institutional history as attached to a Media section which had just closed, and the Graphics section were expanding into the facility for creative purposes, including video production. Malcolm, the young Graphics technician who remained, was technically competent but culturally naive in the context of the shoot in question, having no ingrained milieu-related professional habits to fall back upon. The technology being used was quite complicated with techniques like chromakey demanding a lot of studio time when nothing appeared to be happening in front of you (what you see is not what you get) and also longer pauses for setting up complex lighting arrangements. Psychologically this means that there is less opportunity to take control and get lost in the action. The subjective experience is one of simply lying about in the buff.

When designing this sequence I was aware (and uncomfortable) about recording images of female nudity with a mixed crew (which was the only option that I had at that time). I felt uncomfortable about subjecting another woman to the gaze of three men during the shoot and so I decided that I would be the “actor”. I retained my role as director because I was determined to try to disrupt the power of the male gaze through the process of direction. I hoped to find out whether, by asserting my authority as director, it was possible to expose and disrupt the male gaze and fantasy incurred by me being partially naked and the “subject”.

To interrupt the dynamic of power and control that I associated with the male gaze at female nudity, and between director and directed, I decided that I would need to communicate assertively with the crew during the shoot. I spoke with authority and directed the setting up of equipment and shots. At these times it felt as though the “generalised” other was the traditional hierarchic production crew, with the director in charge. When it came to the first run-through I felt incredibly nervous, and removing my shirt to reveal my breasts was very difficult. On reflection I feel that at the moment of undressing there was a transfer of power from me to the crew. It was as though the character of the generalised other changed, and became based on an awareness of the camera as the male gaze, preying on the female form. I lost my position in the crew as director (literally because I could not speak until the end of a shot) and became the subject of the male gaze (again literally as all the male crew members looked on). The process of being recorded became a series of oscillating “roles”, or shifts of power back and forth. When I verbally directed and controlled the setting up of a shot I felt that I had control of the camera as a means of self-projection. As soon as I stopped speaking and the camera rolled I became aware of the male gaze of the crew, the dynamic shifted and my body became a passive complement to active male looking (Butler). To counter this I spoke to the cameraman to direct the shot, this re-asserted my role as director, the atmosphere was awkward at this point, but gradually through directing I felt more in control and relaxed. The crew relaxed, though I noticed that when they talked to me they seemed uncomfortable and held eye contact for a long time - they dare not look down at my breasts. As the shift in roles continued, always returning from me-as-subject to me-as-director, the two separate generalised others seemed to integrate, and we worked more co-operatively. My authoritative position as director was weakened but it seemed that the act of male looking had also shifted, their subject was not passive.

There were times during the shooting of Sequitur, as with To Be Born Through Our Own Hands, that I shifted from the optimum position for the camera shot. In both cases no physical contact was made between the crew and myself to correct the problem, instead careful verbal instructions were given.

Allowing a decent interval to elapse, I was able to interview male members present on their perceptions of that occasion, and what came through clearly was that my unease had been communicated to the crew. One admitted an inability to view the female breast without his thoughts sliding off into eroticism (Peter: “To be honest, pornography crossed my mind. But not in terms of specific images - just the general idea”). Another comment recognised that the TV studio was a powerful legitimating device but felt he needed to appropriate it to himself by exaggerated behaviour (Richard: I felt like I shouldn’t really be watching, so I gave all my attention to the vectorscopes and the monitors.”) He would, of course, have seen the same content on the monitor although it would have been psychologically distanced by the technology. The lighting technician, Paul, not only picked up Richard’s embarrassment but took great pleasure in it (Paul: “I really hate that guy. The fact that he was having difficulties was really funny. This is supposed to be a technical environment, so how come nudity was adding to the confusion?”)

To my surprise the experience of working with a male crew was sufficiently stressful for me to take the sudden tactical decision to hold the exposure at the level of my naked breasts and not expose my lower body as planned. In the politics of the human body, the genital areas carry the most cultural and emotional baggage. Lisa Tickner’s “The Body Politic: Female Sexuality and Women Artists

Since 1970” (1987) has highlighted the highly charged reactions to the idea of picturing female genitals, placing such images made by women in a socio-historical context. They note that girls are discouraged from exploring their own genitals and that images of female genitals made by men are fetishised, consumable, tempting and sinful.

I also found myself unable completely to cope with the role ambiguities of being both subject and director. In spite of my giving what I had supposed to be crisp directives and commands, I was subsequently mortified to discover that at least one of the male members present had supposed Peter to have been the director all along.

Tentative conclusions

In accord with the double context in which the action research element of this research was set up, feeding back to two separate constituencies, it is appropriate to write up the conclusions in two sections. Both are tentative and cautious in the generalisations that they make.

Conclusions (1): Institutional learning

In relation to the way in which the element of action research in this study fed into the processes of institutional learning, the ensuing discussions have focussed on ways of understanding and thereby improving procedures in two broad areas. The first concerns the dynamics of the video studio as a milieu for creative work when it is dealing with gender-sensitive subject matter. The second concerns management of studio conditions to avoid the constraints experienced and offering practical advice to students, teachers and technicians.

Both from this particular shoot and from others I have subsequently engaged in I have sought to initiate among colleagues some deliberation on how the evident difficulties ought to be understood, not just in relation to practicalities but also in evolving a way of looking at the problems. I have concluded that an adequate theoretical framework is already available in the work of Erving Goffman in such books as The Presentation of Self in Everyday Life (1969) and Asylums (1968).

As David Jenkins (1993) suggests,

“Goffman was a man with an entertaining general theory believing that social “actors” are preoccupied with developing and maintaining plausible performance for each of their settings, a dramaturgy of everyday life that has been likened to the view that people spend all their time “playing ping pong in masks”. The scholars themselves describe their tradition as “symbolic interactionist”, but it adds up to the same thing. (A typical study is Marty Weinberg’s Sexual Modesty in the Nudist Camp which offered among other thoughts the insight that embarrassed nudists raise their eyes heavenwards rather than risking downcast eyes, a behaviour that might in contexts be misunderstood). The context is important, for one of the key notions is W I Thomas’s “definition of the situation”, it is these that the performers are ultimately defending.” p.3

Faced with an awkward or novel social situation the actors in the situation seem to have responded by protecting their various definitions from contextual threats. Moreover, one source of these discomforts seems to be the general ambiguities and misogynies buried in our androcentric visual culture when it comes to body images. The solution must clearly be the development of institutional norms capable of sustaining local norms at least insofar as the video studio in an artistic and intellectual environment is concerned. With my present colleagues at the University of Westminster we have gone some way towards developing milieu-specific conventions and attitudes. Experienced women crews within each of the colleges mentioned, increasingly see themselves as the source of normalising

advice to young women entering the environment for the first time and needing to manage its complexities for themselves. But while wider cultural ambiguities remain, this area will continue, to some extent, to be problematic.

Conclusions (2): Consciousness-raising in women artists

As indicated earlier, one of the frameworks through which an action research strategy was conceived was to treat the two explorations in the video studio as contributing from a local setting to a wider feminist project, namely the deconstruction of images of the female body in contemporary culture and tentative attempts at reconstruction by a community of women artists. As a video artist working in this field I had access to a network of practitioners working on similar problems, and we all saw each others work as tending to support emerging generalisations across settings. In this respect, the collaborative learning taking place transcended the locality of particular observations, without becoming universal.

It might be useful at this point to say something of these other women and what our collaborative project was. One of them was Cate Elwes. It seemed to me that Cate was one of the British and American video artists since the 1970s who used a personalised view to make statements about society. The proliferation of this kind of work has probably developed as a result of two related influences, the first the notion of the personal as political, the second women's sense of alienation and marginalisation. Women video makers have often used themselves or their female friends as the basis for their work, describing personal experience and commenting on women's lives by recording everyday situations. Rather than being biological or anthropological records, these are often pithy or allegorical works juxtaposing images and sounds and commenting on larger issues. Cate

Elwes Video Postcard did this by recording images of her dressing her baby and supplementing it with a voice-over. The voice-over is the content of a postcard to her mother, which tells of her exhaustion and worry over her baby's constant and unremitting crying, which begins as soon as she starts to dress him. Dressing the child is gradually revealed as a conflicting act of love, necessity and torment, almost an act of cruelty, perpetrated out of the necessity to protect the baby from cold. From this we get a sense of the complex emotions of motherhood, although at the same time hinting at the absence of a maternal or "instinctive" solution to the baby's crying. Motherhood becomes bewildering, breast-feeding is shown as painful and almost violent (Cate Elwes, 1985). In her piece the image of the child at the breast is denied us in its usual form; instead the screen is filled with the breast that the child is not sucking from. Elwes shows the relentless bashing of the left breast as the child drinks from the right (the nipple rarely comes into frame) and as a result the convention of associating the erotic with the image of the breast is interrupted. The image dispels the notion of the Madonna as blissful at such a time and the child becomes unexpectedly active and powerful.

We were all aware that this kind of women's corporeal autobiography could be disturbing in its honesty. In a work cataloguing her breast cancer and mastectomy, the late photographer Jo Spence had similarly demanded that the viewer looks at the breast in a different way. Spence photographed her breasts before and after mastectomy:

"Passing through the hands of the medical orthodoxy can be terrifying when you have breast cancer. I determined to document for myself what was happening to me. Not to be merely an object of their medical discourse but to be the active subject of my own investigation."

Spence (1986) p.153

This use of self-imagery for cathartic purposes has sometimes been called “photo-therapy”.

The work of Jayne Parker was particularly interesting to us for another reason, since she sees her work as an assault on the “fetishisation” of the very video technology that she is using, which she attempts by bringing in the technology rather obviously within the piece, a kind of visual equivalent of Paris’s Pompidou Centre. Jayne Parker’s complex video, Almost Out, is an excellent example of this. She and her mother are recorded sitting naked in a video edit suite, surrounded by electronic technology. Parker operates the camera when recording her mother and simultaneously conversing with her. A male camera operator records Parker, who ambiguously asserts herself against the (invited) male gaze by leaning forward and altering the lens and sometimes by switching the camera off. We are constantly aware of the relationship between the camera, the camera operator and the women sitting in front of it. The process of recording is played up, becoming part of the subject rather than aspiring to invisibility even as it suspends the viewer’s disbelief.

Another artist whose images seek to affect social change by drawing attention to external factors which oppress women is Roberta Graham who like me is working with the unclothed female body at a point where fantasies and realities overlap. Her Short Cuts to Sharp Looks (see Fig 22) employs photo collages of women’s faces which seem pierced and held together by surgical instruments and comments on the beauty myth with a “probe into the horrors of plastic surgery” (Kent, 1980). Her disturbing images and the maladaptation to androcentric culture that these self-inflicted wounds imply has been nicely explored by Sarah Kent (1980) in “Pretty Promises, Happy Traps”.

These women shared a background of experiences with me as they all had been part of mixed group life-drawing classes and had noticed the tensions between the women models, male staff and male students. Different models responded differently to the day to day problems in the class. One male lecturer from the Fine Art Department at Sheffield City Polytechnic had developed the habit of physically moving a model's leg or arm if she moved out of position after a break. I saw this happen a number of times and the women models said nothing to him, but a new model gave him a great shock by angrily telling him to take his hands off her. This caused a ripple of shock in the class, but a lot of women students exchanged relieved glances that finally someone had stood up to him. He never attempted to touch male models in the same way, and years later I was struck by this when I read an article which described women as the "touchable caste".

One locale into which I have been able to feed my findings is a women's group known as Cutting Edge, a small British research group comprised of women from design, media and culture studies background who meet regularly to discuss subject like the female body and its place in design and technology. Its members include Erica Matlow (lecturer in Graphic Information Design), Stevie Bezencenet (lecturer in Media), Roberta McGrath (lecturer in Communication), all from the University of Westminster, Phillippa Goodall (photographic curator of the Bristol Watershed), Janice Winship (lecturer in Media Studies, University of Sussex), Jos Boys (lecturer in Architecture, De Montfort University) and Helen Coxall (writer on Museum, Language and Text). From the point of view of Cutting Edge, this research arising out of my own experiences as a cultural theorist and videomaker is one of a number of explorations through which the group is seeking cross-site generalisations. What has developed through months

of arduous and sometimes frustrating attempts at collective understanding is a strong sense that we are exploring similar territories that have a similar problem configuration, although one made more complex by situational and theoretical differences. We are currently planning a one day symposium, “Desire by Design” which is seen as the first of a potential series of symposia to forefront the intersection of these discourses. The interests of the group span a wide range of subjects including home shopping, surveillance, reproductive technologies, technological augmentation of the body, medical imaging technologies, VR and the design of architectural space, technological space and territory. I would claim this as an example of the legitimate appropriation of action research strategies to facilitate non-institutional learning.

I have confined my conclusions in this section to the deliberations that came immediately out of the experience of the shoots. How this feeds into the much wider questions addressed in the thesis as a whole will be taken up again in the *General Conclusion*.

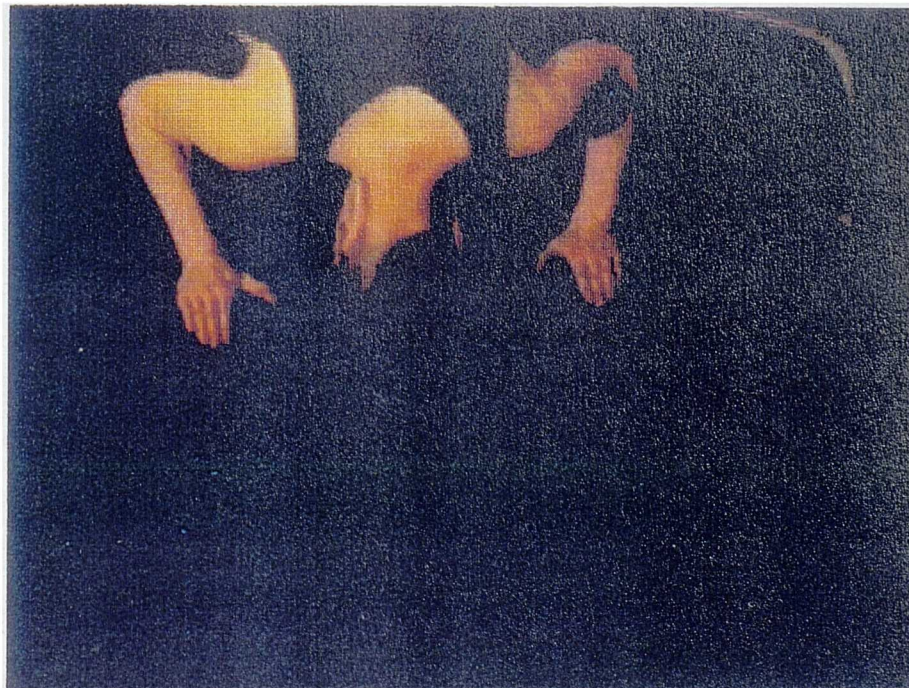
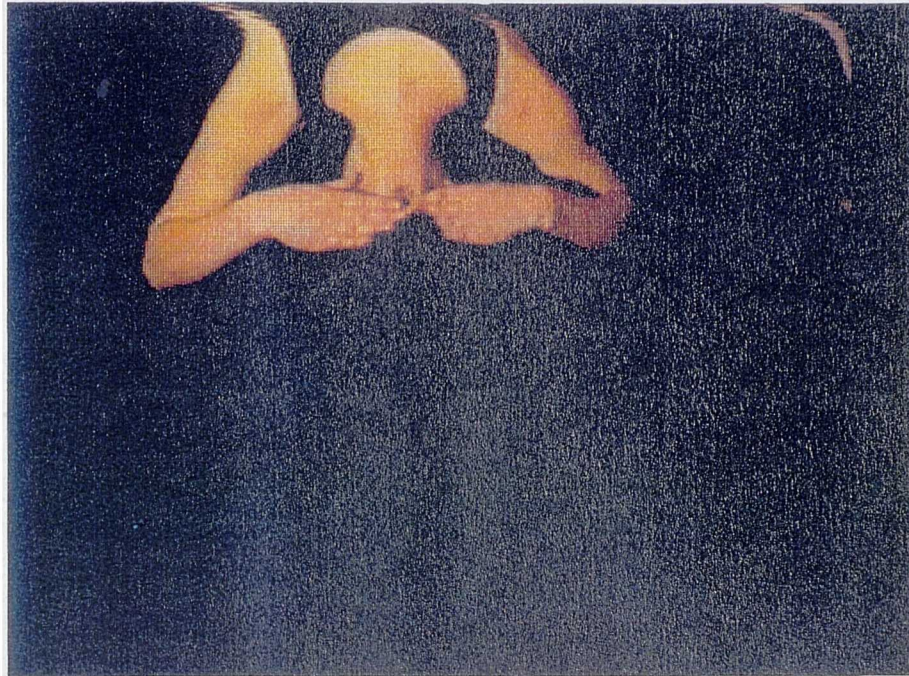


Fig20: Stills from To Be Born Through Our Own Hands by Jane Prophet, 1987.

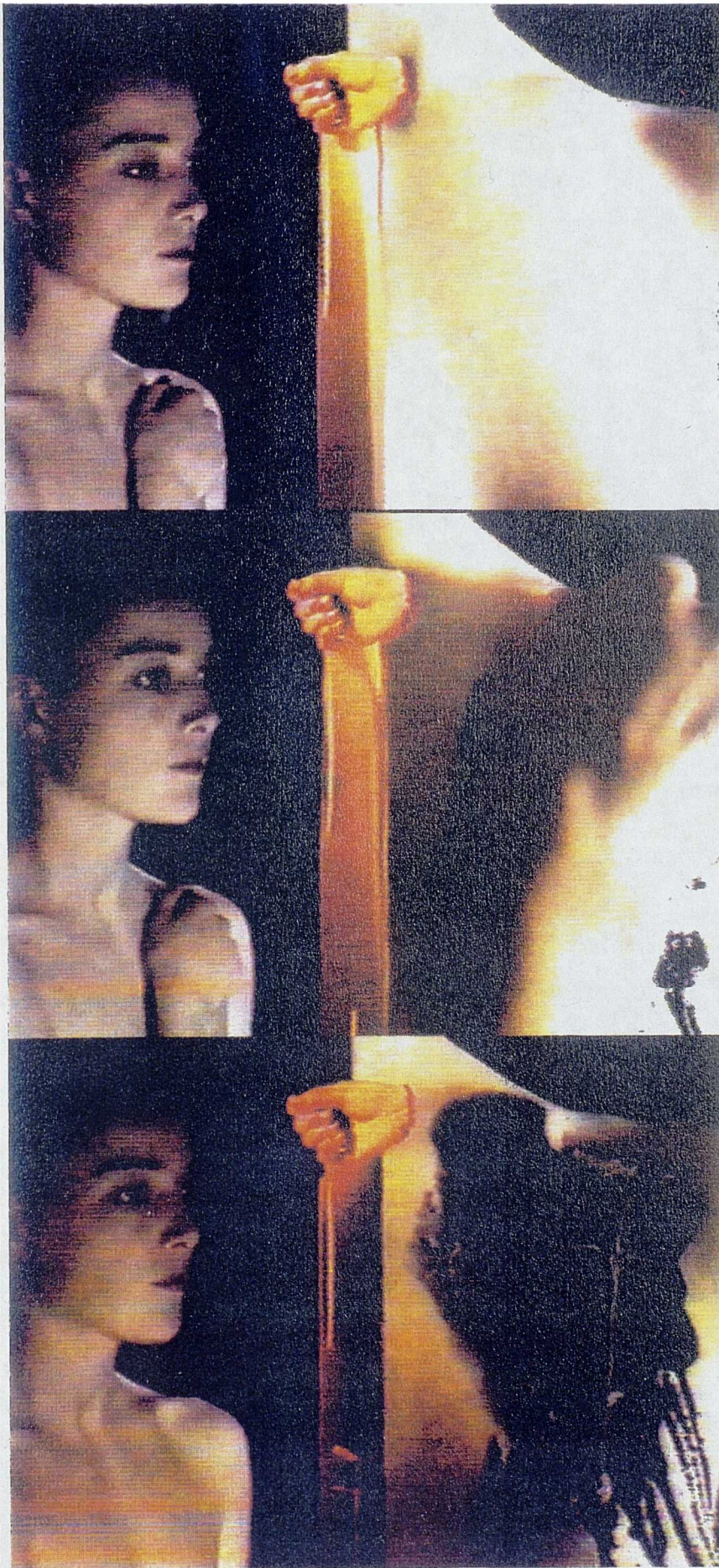


Fig 21: A mixed crew was used to shoot this sequence from Sequitur 1990.

TOWARDS A NEW AESTHETIC?

A variety of discourses are associated with the “text” of computer generated art. The aim of this chapter is to explore the various languages which together form the aesthetic “heteroglossia” (Bakhtin) associated with computer generated artworks. Stam (1988) defines Bakhtin’s concept of “heteroglossia” as

“a notion of competing languages and discourses which would apply equally to “text” and “*hors-texte*”. Heteroglossia refers to the dialogically-interrelated speech practices operative in a given society at a given moment, wherein the idioms of different classes, races, genders, generations and locales compete for ascendancy. It refers, further, to the shifting stratifications of language into professional jargons (lawyers, doctors, academics), generic discourses (melodrama, comedy), bureaucratic lingos, popular slangs, along with the specific languages of cultural praxis.”

Stam (1988) p.121

This chapter takes as problematic a complexity of issues surrounding the aesthetic heteroglossia of art appreciation in the computer age. In the history of computer graphics, the links between large economically powerful organisations and computer image research are numerous and significant. These organisations have channelled funds for research into computer imaging technologies in specific and narrow directions and the resulting technological advances have in turn influenced the “look” of computer generated imagery.

Computer scientists have an important place in the heteroglossic clamour surrounding computer images; they are at the forefront of research into computer imaging and many of them work on projects with substantial financial backing from industry and defence organisations. The computer scientist uses images to illustrate techniques, like rendering, rather like a couturier uses a mannequin upon which to hang clothes, and indeed to many computer scientists images are like graphs which plot the development of an imaging technique. Achieving particular

visual effects is often the computer scientist's response to a problem which has been identified by a commercial or military group.

Images produced by the mathematician Benoit Mandelbrot to illustrate theories of recursivity and chaos have inspired a wide range of people, including those with an interest in psychedelics. There is a thriving "cyberpunk" subculture populated by people (mainly male and white) from a range of professional and backgrounds who have made fractal images, with their fascinating recursivity, into cyberpunk mandalas. Amongst this group are a significant number of New Age thinkers, some of whom are interested in experiencing altered realities. Though we are currently witnessing a resurgence of hallucinogenic drugs (the most popular of which is Ecstasy) there are large numbers of both ex-acid-heads and others who have never been supportive of illegal drugs, but who have turned to smart drugs and meditation to assist them in their search for altered states. The future possibilities of Virtual Reality systems have great appeal to these seekers, who see VR as the means to the ultimate "trip", one which offers the altered perceptions so loved by consumers of LSD, but which has the advantage of being a controllable experience, the participant being able to enter and leave it at will and with speed. As the cyberpunk culture reappropriates scientific computer images, like Mandelbrot's Julia sets it attracts the attention of computer scientists.

The design of the machines which are used to create and present digital images carry with them discourses associated with the high tech look and functionality, both actual and implied. The "hidden" design of operating systems (the code which controls the computer hardware) determines the "user-friendliness" of a machine, which in turn influences potential users who may or may not want to write programs in order to make images. The combination of this code and the

more visible hardware (monitors, microchips and processors) determines what the machine is capable of, such as whether it will generate images in colour or black and white, or whether it can operate complex modelling packages or not.

Hardware also circumscribes the output of images, determining whether they are printed on plotters, greyscale printers, colour printers, become objects cut out of layers of resin, or are recorded on film or video or viewed on the screen.

The technical attributes of these machines affect and sometimes determine the characteristics of artworks created with them. Some of these characteristics are shared by elite art forms, for example the reproducibility of computer images has much in common with the multiple screen printed images made by Andy Warhol. Other characteristics like the potential for “sampling” existing images cause tensions within established “high-art” aesthetics; at the same time using the computer makes it possible to subvert these images by appropriation and alteration.

Occasionally large corporations fund artists (IBM have supported the sculptor William Latham) and companies donate expensive equipment to colleges (Symbolics have recently given half a million pounds worth of equipment to Duncan of Jordanstone College in Dundee, for a post-graduate course which aims to encourage artists and programmers to work in teams on computer and video projects). These initiatives bridge the divide between art and science, education and industry. As computer scientists produce images for their own sake rather than to illustrate a mathematical formula, and as these images are reinterpreted by people in other locations as art rather than graphs, so the shift in function from scientific evidence to art image further disrupts the boundaries between art and science. As Virtual Reality systems are used by artists with intentions other than

of producing simulated environments within which to recreate reality, the gap between the commercial and the art world is traversed (North West Arts is currently developing initiatives which seek to promote the use of these systems by artists). Organisations like MIT and the London based community project Art Tech encourage collaborations between artists and programmers in order to produce hardware, software and artifacts. This has also contributed to the erasure of the barriers between artists and scientists. Each of these groups conflicts and yet dialogues with every other; and the resulting cacophony is filling the split between art and science, contributing to what is fast becoming the new aesthetics of computer artworks.

“Aesthetics” and “creativity” are contentious terms when it comes to discussing art produced with computers. Though the term “aesthetic” is used to describe many spheres of life from social interaction to dressing, it is predominantly presumed to apply to the arts, and, more specifically to the visual rather than musical, literary or performing arts. Traditional aesthetics is not coping well with the challenges posed by images produced with computers, and in response to this a “new” aesthetic is emerging. The characteristics which have traditionally been associated with these terms (such as “genius” and “uniqueness”) are being challenged by both the processes that artists using computer technology employ, and by the images that result from these processes. The romantic definition of creativity, based on the notion of the individual genius as the only begetter of the aesthetic monad, is colliding with characteristics of art produced with the computer with its potential for making numerous versions of multiple images, often by plundering components from pre-existing images. In response to this collision, technology has again been attacked by some as intruding into, and violating, the creative process. Creativity is often translated as *doing* rather than

seeing. In education creativity is often presented as the process of

“the faithful recording of how things are (the very antithesis of being “creative”...).

Redfern (1986) p.7

With the photographic process, distortions of such faithful recordings are also facilitated. Though it has become accepted that the photograph cannot be finally relied upon as a signifier of truth, the photographic process has finally become accepted as a tool worthy of the artist. Computers can be used for producing and storing images in a similar way to the photograph, and not surprisingly there is currently a race by large corporations like Kodak to buy up the resources of smaller photo-libraries. Computer technology has provided the opportunity for storing vast numbers of photographic images on disk, allowing rapid display, easy manipulation and combining of disparate images. Photo-libraries are a rich source of collections of these images and by buying them out large companies are seeking to corner the market. Computer imaging technology allows for rapid manipulation of scanned photographic images and it could be that with the act of faithful recording accomplished photographically, textual readings of images, and questions regarding the proof-value of such recordings may be more likely to be addressed because the truth-value of a computer image is so obviously open to debate. The cross-over from photographic to digital processes is being accelerated by the introduction of products like the Canon Ion camera. Rather than storing them on film, which then has to be processed and printed, the Ion camera records the image onto a computer disk. Each disk holds up to eighty pictures and the camera can be plugged straight into a Macintosh computer, from which the images can quickly be transferred to any desk top publishing program, or to a digital retouching program.

Artists using new computer technology are working in an area of image-making which has strong connections with the popular cultures of science-fiction, music, film, advertising, comics and fashion. In attempts to halt the devaluation of computers as a medium for artists (and as a reaction against the gallery system which has rejected them) artists using computers are distributing their images via record sleeves, as projections during gigs and club nights and on billboards. The audience which sees this work is different from that associated with the art gallery, and this may be contributing to the shifts in taste that are occurring with regard to images produced with computers. This audience, predominantly a youth audience, and increasingly well-informed about the technical aspects of computer applications (having grown up alongside computer and video technologies) is largely captivated by the potential for applications in areas like Virtual Reality. The aura that computer technology holds for this audience is reinforced, not by art critics and other “experts” from the art world, but by cult writers like William Gibson and re-emerging Sixties “gurus” such as Timothy Leary, both of whom add spice and “street-credibility” to the computer as an entertainment and pleasure-inducing technology. The use of computers in hypermedia applications in schools and universities adds the weight of implied academic value to the computer, and the common analogy made between computer programs and neural networks reinforces this.

Aesthetics and technological art

There is frequently a comparison made between early photographers and “visually illiterate computer practitioners” (Hudson, 1987, p.169). Hudson points out that both early photographic work and recent computer images attempt to

emulate historical forms of art, rather than to create something that is specific to the medium of the camera or computer. It was relatively late on in its history that the medium of photography was recognised as a creative tool/medium in its own right, and not simply a means of documentation. Even now, in the debate surrounding digital imaging and photography, the threat to the status of the photograph as an objective and reliable form of documentation is the point of contention most frequently aired.

The photograph as scientific evidence

The introduction of photographic technology had a profound effect on the way in which people perceived the world and how art functioned. With the development of the photographic process it was no longer necessary to paint or draw in order to have a record of something or someone, so paintings and drawings could have a function other than that of a descriptive recording. Certainly the photograph provides a quick and seemingly accurate description of what is in front of the camera and within range of the lens, and it became quickly accepted that the “camera never lies”. Photographs came to be seen as in some sense indisputable visual evidence of an event having occurred. The association of the mechanical with the rational and objective reinforced the idea of a photograph as an image capable of carrying its own undeniability, safe from emotional or subjective tampering. The photographic process was scientific and therefore to be respected. The famous, or infamous, photograph of fairies at the bottom of an English country garden is a good example of the power that the photographic image has to persuade people of even the most unlikely events and scenarios.

The controversy which surrounds the use of the photograph as reliable evidence

of an event has been highlighted by writers such as Barthes and Sontag. Barthes writes that the photograph is usually inseparable from the thing it represents (Barthes, 1981) but he also comments on the signifying elements in a photograph which effect its “reading” (Barthes, 1982). Just as objects can be physically altered before a photograph is taken and changing elements like the camera angle and filter can contribute to a particular reading of an image, so in digital imaging the computer can be used to make changes to an image. The computer has the advantage over the photographic process in that alterations can be done very quickly and with fewer limits or constraints. Shifts or transformations which would depend on prolonged manipulation under darkroom conditions if done photographically can be achieved digitally in a fraction of the time. Also, the photograph has a resolution that is many times greater than that which can be achieved with most home computers, which means that digital retouching is most appropriate when the image will be presented in a form where low resolution is acceptable (such as newspaper articles or television). Screen resolutions vary from four hundred dots per inch to two thousand dots per inch.

Circumstances define the acceptable limits of resolution, with different situations warranting different resolutions of image and text. A low-resolution version of a photographic image is satisfactory for designing magazine or book layout, but a high resolution version is required for the final printed book or journal. In medicine, images transmitted via an endoscope provide a low resolution screen image of, for example, coronary arteries during an angioplasty (see Fig. 22), yet in all but the most clear cut cases a printed version of these images (an angiograph) showing the arteries at higher resolution is needed before any further action is taken. It is important to remember that though a computer screen can limit the detail (resolution) available to the user while working on the image, the

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image itself can be stored at a much higher resolution and printed out satisfactorily. This option has placed the computer in direct competition with the photographic process.

Art and technology: the aesthetics of the future

The art world has begun to acknowledge the influence of computer technology as was illustrated recently by a series of seminars organised by the Institute of Contemporary Art entitled "Towards the Aesthetics of the Future". These seminars seemed designed to provide a public forum in which to discuss and re-evaluate aesthetics in the light of technological advances in computing, and was the first high profile event of its kind held by the ICA since its controversial Cybernetics Serendipity exhibition (1968). The series comprised of

"...five presentations and discussions exploring the impact of new technologies on the moving image ...Digital technology, interactive media, Virtual Reality, high definition television and computer graphics are radically affecting our visual and media environments. They are also shaping the future directions of the creative arts. Towards the Aesthetics of the Future is ...designed to explore and debate this impact."

(ICA cinema programme September-October 1991)

The seminars about Multimedia and Virtual Reality usefully informed the audience of technological advances and current limitations, but the speakers seemed surprisingly unwilling to engage directly with the central question of aesthetics. The problem was partly a matter of the organisers misjudging the prospective audience. In spite of ICA's declared agenda, the presentations tended to have a trade show flavour about them, an irony reinforced by the locale - they took place in a cinema within an art gallery.

What the seminar series lacked was any coherent discussion of the impact of these technological advances on a reconfigured aesthetics. The focus on image-making technique perpetuated the fetishism of the computer as technical commodity. The pieces of equipment used to make the chosen images were predominantly of a prohibitive cost and rarity, thereby reinforcing the “aura” of the machine and diverting attention away from the need to discuss the emerging characteristics of the kind of art produced with computers, where it could be situated in relation to other dominant art forms, or how its formal qualities related to the process of production.

Collaborations between artists and scientists

William Latham, however, conducted a seminar as part of the ICA series which managed to have a distinctly different feel. His concern was for his own creative process and for the relationship forged between the computers, himself and his team at IBM. Information about recent technological advances and processes were integrated and cross referenced to sculptural forms, and in particular the characteristics of sculptures which exist primarily in the simulated three dimensional space of the computer. Yet wider questions of aesthetics raised by the audience, related to the gallery system and whether the program or the images constituted the “artwork”, were deflected by Latham.

The artistic scientist and the scientific artist

The move towards image making by scientists and the simultaneous use of computers by artists has resulted in a blurring of the boundaries between the two. Whenever there is a forum for showing images made with computers, both artists

and technologists exhibit side by side, but individuals are reluctant to define themselves as either one or the other. The first computer graphics competition was won in 1963 by military researchers in ballistic missiles. 1965 saw the opening of the first computer-generated art exhibition in Stuttgart, presenting work by three mathematicians, Frederick Nake, A Michael Noll and George Nees. In America that year there was a parallel show of work by scientists engaged in research on sounds and images made with computers.

This weakening of the distinction between artist and scientist is typified by William Latham who began his artistic career as a sculptor using traditional materials, and recently became educated in science in order to use sophisticated electronic media to create computer-generated “sculptures”. Latham writes papers for scientific journals, like SIGGRAPH, sculpts using computers and has learnt to program. He is funded by IBM, who also funded the inventor of fractals.

Art/science hybridisation is not limited to the visual arts; BMB Con, a Dutch sound performance group, have recently been experimenting with making their own video projector by dismantling LCD monitors and attaching them to slide projectors to project video images at a low cost. This is a logical progression for them as much of their sound performances depend on their interfering with amplification and using computer midi systems to distort live sounds. While these practitioners’ experiments may never be acknowledged outside the narrow social context of their performances, there are others whose work on art imagery contributes substantially to the progress of new technologies. Margeret Benyon is one such woman who began by expressing her creativity as a painter and then pursued her interest in holography:

“...she found an immediate pragmatic link between the new medium (holography) and the objectives of her years as a painter where she had explored the interference patterns and the basic spatial propositions of the flat canvas.”

Peake (1980) p.94

Benyon's approach to holography relates strongly to painting and drawing techniques. She sometimes works on the surfaces of her holograms, scratching into the emulsion rather like a printmaker working on an etching. An article in the Bournemouth Evening Echo of 1984 charts her drive to take holography out of the scientists' laboratory and into the gallery. Holography has remained marginalised, rather like computer imaging, but there a steady stream of interest in it, though it has so far not become widespread as a practice, probably due to its expense. Holography has recently become more commonplace with holograms appearing on cheque guarantee cards, badges, banknotes and even postage stamps. Its persistent appeal is borne out by a recent request from students on the media degree course at the University of Westminster, for a module in holography and as there is an expert within the department I am sure that they will get it. The Royal College of Art has also invested in laser equipment to facilitate holographic artworks and runs a popular artist-in-residency scheme to attract practitioners and fuel student interest in the medium. Benyon's interest in holography has attracted some attention:

“Among painters using holography she is unusual in that she is immediately occupied in widening the scope of the medium through technical research which she is at present carrying out ...she is gradually exploring a field as mysterious and pregnant as that of the early photographers or the early cinema.”

Russell (1970)

Though Benyon acknowledges the importance of her technical prowess, the artistic qualities of her work remain paramount:

“I see my own use of holography in art as complementary to the objectives of engineers or of scientists. As an artist, I want to develop its unique properties. It could be very disappointing if new visual ideas were not realised through it.”

LIP (1980) p.94

The new visual ideas that Benyon works on are accompanied by her interest in developing new techniques as appropriate, the ability to transcribe computer generated objects to holograms and to amalgamate them with portraits is one approach which interests her (The Photographic Journal, November 1988).

While the work of Benyon, Latham, BMB Con and others is concerned with technology and situated on the borders of established art aesthetics, pushing them forward to some new realm, it retains many close links with the art world as all these practitioners share a background in the fine arts. They are producing images and sound from the foundation of an art aesthetic despite sometimes feeling that this aesthetic does not serve them well. Scientists producing images are the other inhabitants of this site of collision between art and science, and their images have grown out of a scientific aesthetic.

Fractals: a scientific aesthetic

There is one area, the significance of which goes beyond mere contemporary fashion. I refer to recent work on fractals, which have produced stunning visual imagery as well as representing a breakthrough in chaos theory. Mandelbrot's fractal images (see Figs. 23 and 24) have certainly captured the public

imagination with their icon status by no means confined to those who understand the mathematics. The visual impact of these highly coloured fractal graphs is matched by the impact of the characteristic *increase* of detail the closer that a fractal form is studied.

In The Beauty of Fractals (Peitgen and Richter, 1986) scientists can be seen making new claims on behalf of the breathtaking beauty of these fractal images, turning the scientists into latter day artists. Yet this claim, echoed in Mandelbrot's belief that fractals are a novel anti-minimalist art (Mandelbrot, 1983), collides with the post-Renaissance assumption that scientists and artists have very little aesthetic common ground. A more interesting possibility is that computer scientists are making a major contribution to an aesthetic shift. Their icons form a complex interweaving of fact, fiction and fantasy, a mix thoroughly compatible with developments in taste which are affecting other subcultures.

Computer scientists: no aesthetic or a different aesthetic?

Fractal images were not initially created to function as art but were more like elaborate graphs. They are pictorial visualisations of dynamic systems used to encode mathematical information. Using a pictorial rather than written format enables a far greater flow of information and makes it easier to see connections, networks and interactions. Fractal images are based upon mathematical insights which Eilenberger describes as

“the most exciting development since the discovery of quantum mechanics ...insights which will revolutionise our scientific view of the universe”

Eilenberger (1986) p.176

Fractal mathematics is an area of maths which can be represented by computer programs which can produce graphical images. Fractal images seem to refer to shapes found in the natural world, for example fractal random walks look similar to coastlines. These images are produced with mathematical procedures called “iterative processes” which allow the computation of arbitrary amounts of detail within a shape: for example, it is possible to zoom into one section of a fractal image and to compute more detail as you zoom in sampling the characteristic general conformity across scales that fractals exhibit. For example a rough but robust model of a fractal coastline can be generated as follows; firstly two points are set up on a plane and a line drawn between them, referred to as a line segment; the centrepoint of the line segment is then chosen and has a random displacement applied to it, forming a “V” shape now consisting of two line segments. The same procedure is applied to each of the two line segments but with smaller deviations to the midpoints, and this is repeated over and over again to subsequent line segments until a level set by the user causes the process to halt. The process is one of recursive subdivision, and has the consequence of adding arbitrary amounts of detail to the coastline. Interestingly, increase in the level of detail permitted has the effect of lengthening the coastline, which in theory could, in terms of the model, achieve infinite length (Mandelbrot, 1982).

The video makers “Strange Attractions” have made a four minute video called Where No Penguins Fly which is a colour cycled Mandelbrot set. The familiar image of the Mandelbrot set, which has become a computer graphics icon, is shown with changing coloured segments, implying both movement and metamorphosis, through the cycling of colour. The program used to generate this sequence (or something very similar) is now available as a screen-saver. This video work is distributed by the Film and Video Umbrella, a video and film art

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distributor. The Art and Science series that it forms part of is funded by the Arts Council and the British Film Institute and includes other science-like videos such as Optical Experiment which looks like a highly magnified crystal growing in real time.

Beauty, fractals and chaos

Eilenberger has been puzzling recently over the roots of aesthetic preference, why the silhouette of a storm bent tree is considered beautiful whereas a multi-purpose building is not. His conclusion is that beauty is created by a harmonious counterbalance of order and disorder. As fractal images represent the science of dynamical systems which are a blend of order and chaos, they clearly fall within the line of argument:

“They [fractal images] demonstrate that out of research an inner connection, a bridge, can be made between rational scientific insight and emotional aesthetic appeal ...Science and aesthetics are in agreement about what is actually missing in technical objects as compared to natural objects: it is the luxury of an appropriate portion of irregularity, disorder and unpredictability.”

Eilenberger (1986) p.180

This essential irregularity is central to the debate which surrounded early computer art works by the mathematician A Michael Noll. In 1965 he produced a series of facsimiles of famous modern art works, including a convincing pseudo-Bridget Riley and a semi-random non-derivative image made with a microfilm plotter and digital computer, which ended up surprisingly similar to a famous 1917 Mondrian composition (see Fig. 25). Meyer Shapiro, an art historian of some repute, took great interest in the production of this work and the subsequent experiment that Noll performed. Noll asked one hundred people to compare the

Mondrian with the computer picture and name which was which and which they preferred. Only twenty eight percent could say which was the computer image, and out of the one hundred, fifty nine preferred the computer image (Goodman, 1987, p.25-26). Shapiro became sure that it was the randomness that had caused the confusion and convinced people that the computer drawing was produced by a human hand. The association of randomness with creativity may be traced back to the belief, first prominent in the late seventeenth century when it was voiced by Thomas Burnet, that nature is worthy of aesthetic consideration alongside art as it is the art of God, exhibiting natural harmony. Such harmony has random elements reflecting the order-disorder of nature. The development of chaos theory (Gleick, 1987) with its techniques for describing dynamic systems, is having a similar impact on aesthetics as it provides a rationale for unexplainable and random events. Previously these were more readily given form and explained through poetry and art.

A scientific equation for beauty

Contributors to computer science journals such as Herbert Franke have tried to come up with an equation for beauty in order to test computer graphic images and categorise them as art. Franke deduces that

“if any collection of visual information is presented in such a way that it achieves optimal visual recognition, eg. with the help of a computer, then there will be simultaneous convergence with the characteristics of the Beautiful, *which are* a harmonious arrangement, balance, symmetry”

Franke (1986) p.184 *my italics*

Franke thus conforms to Plato’s concept of beauty, in which he responded to the

order and symmetry of simple geometric figures, valuing overall harmony, regularity and simplicity. On these criteria many of the early computer graphic images which utilised three-dimensional modelling software (see Fig. 26) would be admitted.

Franke, under the influence of psychological theories of creativity, adds “innovation” to “beauty” in his list of ingredients needed to make a work of art, which needs to provoke interest and gets the viewer involved. It was their bright colours and iterative patterns which made the Mandelbrot set look unlike most mathematical images. Spectators who had no mathematical understanding of them interpreted them as psychedelic images like the Op Art paintings of the 70s, and indeed images of Mandelbrot sets rapidly became very popular with psychedelic and cyberdelic sub-cultures.

The influences that funding for computer graphic research has on computer art

Computer graphics - the term

Confusion has been caused by the blanket use of the term “computer graphics” to describe any image that is made with the assistance of a computer. It was an aeronautical researcher, William Fetter of the Boeing Company, who coined this phrase in 1960 when he was describing the technical drawings of a cockpit which he had produced on a plotter (Goodman, 1987). To decipher which computer images are art rather than graphics it would be helpful, but not necessarily definitive to be able to identify for possible elimination work which is exclusively commercial. Even such products can in some circumstances be rescued by a

contrived shift in taste, and in any case commercialism is a matter of intent, and will not matter to responders tutored in the intentionalist fallacy. Nonetheless it may be provisionally possible to establish criteria with which to evaluate this new medium as a not entirely accidental artistic tool, by separating computer graphics into a range of different images created in response to different desires, and with different functions.

Computer graphics or computer art?

The characteristics of graphic design include commercial viability and an awareness of current “looks” (especially those associated with popular music, culture and fashion). Graphic art is used to inform, to sell, to promote; it fulfils a defined and specific task. There is, however, a bifurcation in response. The typical “mere” graphic image functions as an indicator to another product, whereas there is a settled disposition to see artwork as in some irreducible way a product in its own right. Computer graphics has inherited this twin cultural legacy, its images often promoting and selling the hardware which makes their production possible. In the opening paragraph of his article Beyond Computer Art, Brian Reffin Smith (1989) alludes to apparent monopolisation of “computer art” by companies which produce hardware and software:

“this “art” is actually a demonstration of the power of a few companies’ computer graphics ...most of the “art” is really graphic design, produced for graphic design-like (and thus not art-like) reasons; and finally that there is a sort of “mafia” of people who produce, teach, write about, judge at competitions and generally celebrate and curate this “art” ”

Smith (1989) p.39

Smith goes on to point out that the producers of computer “art” are often linked to

commercial concerns and have

“been able to push ideas of technological determinism (the idea that what is technologically possible is therefore desirable, even along other cultural dimensions) and of commercialism, and of spurious, meretricious representation, into the minds of those critics, artists and curators who should have known better.”

Smith (1989) p.40

I endorse this judgement, which is echoed by Graham Howard, ex-Coventry Polytechnic design tutor. In Towards a Critique, Howard notes that it is predominantly computer *graphics* that has been what the computer has applied to in art and design. He goes on to claim amazement that there has been so little discussion in the media

“of the way the technology has impacted upon the kind and quality of the images produced by artists and designers.”

Howard (1988) p.39

Although they may be commercially viable and fashionable, art images usually function differently from graphics. An analogy may be drawn with Rauschenberg's The Critic Laughs which was an object designed by the artist but produced and packaged in a factory alongside everyday commercial items. It was marketed using a well-judged commercial strategy that made it only available for purchase from selected galleries. Through following so closely the plastic gimmick fashion of its time and being marketed like any other commodity, The Critic Laughs sought to make ironic comment on its own mode of production by making indirect reference to the ambiguities of the gallery system.

While much commercial graphic work seeks to distract the viewer from its mode

of production, there are occasions when it is commercially appropriate to refer to it, especially when it involves technology which is new and presented as exciting and desirable. Television graphics for the countryside programme The Country File make the use of computer technology self-conscious. On the television screen we see the borders of a computer display, with commands and menus on view as the graphics are displayed. This emulates the current trend in interactive media, where it is clear to the viewer what technology is being used, a technique which counters the image of this type of programme being rather down-beat and low-tech. Frequently mock-ups of possible interactive computer and video programmes are created with this type of effect, although there is no real interaction (other than the options available to the television viewer). The images are linear and sequential, and it is not practically possible to change their sequence. Yet the images themselves retain an implied or suggested interactivity, by borrowing the frisson of computer graphics systems.

John Craig Freeman is one of a growing number of artists who produce billboard art to great effect and combine this form of display with computer technology by designing images on computer. The billboard series Operation Green Run (see Fig. 27) used thousands of images, which when tiled made one picture. The images themselves were printed on a laser writer and reassembled by hand. Using billboards to display work is an alternative to using galleries and is one of many such alternative distribution mechanisms utilised by artists, especially those producing electronic and digital images:

“I share the belief with many contemporary artists who deal with socio-political aesthetics, that the art gallery or museum is losing its use and relevance in society. One solution to this dilemma is to present the work in the public domain.”

Freeman (1991) p.39

A historical background to computer graphics

Initially computers were free standing and did not run software as we know it. The first computers were programmed by rewiring: technicians wandered down vast rooms full of valves and changed the connections between them. After this came punch cards; programmers who were not on site could punch cards, which were then loaded into the computer by technicians, the computer translating the holes into binary code. The development of the first Personal Computer (PC) was a significant step towards making computers accessible to individuals. PCs were cheaper and easier to handle.

The influence of flight simulation

Two key figures in early computer graphics, Evans and Sutherland, formed a company which developed some of the first computer graphics equipment and later military flight simulators. Ivan Sutherland's doctoral thesis, completed at the Massachusetts Institute of Technology (MIT) in 1962 on his Sketchpad project became famous, and even the film depicting him operating Sketchpad itself became a computer graphics icon, shown over and over by enthusiasts. Sketchpad was an interactive graphical drafting system whereby the user used a light pen to draw directly onto a screen (cathode ray tube). Any movement of the photoelectric cells in the pen as it moved across the screen was transcribed to a path of light displayed on the screen. Lines could be made to run parallel to each other and/or be of equal length. If the user designated two dots, the computer would draw a line between them; similarly circles might be drawn around centre points. Sketchpad thus facilitated the drawing of basic geometric shapes which

were relatively simple to execute and which the computer could save and recall. It was one of the first examples of a computer which could be used to draw, and after being demonstrated on television, the arrival of the facility rapidly gained cult popularity. Computer buffs and image makers with an eye on new technology eagerly awaited the next development.

Not surprisingly, Sketchpad attracted funding from the military because of its potential as the technical basis for the development of flight simulation. It was the first of many innovations in computer image-making which would owe their subsequent development to funding from Ministries of Defence. Adequate flight simulators have a performance requirement to generate images in “real time” in order to create the effect of flight through the “represented” landscape which needs to be rendered with at least sufficient minimal plausibility to act as a substitute landscape and air space for the development of flying skills, by a computer. “Real time” is a slightly ambiguous term used to describe a screen update rate which makes movement through a simulated landscape appear smooth. It is calculated as anything from one picture per second to over fifty pictures per second. The most common screen update rate in flight simulation at present is fifty pictures per second (which is equivalent to TV screen update) but there is demand for faster update, of say seventy pictures per second (John Vince, 1991, ICA talk). A faster rate would eliminate the problem of flicker which the eye registers when viewing the screen peripherally (look at a TV screen out of the corner of your eye to see this effect). In the drive towards faster image processing, millions of dollars have been invested in digital imaging and many of the painting and drawing packages that are currently available on the domestic market are off-shoots of this multi-million dollar industry.

Flight simulators are designed to respond to inputs made by the pilot via the simulator controls and generate the appropriate imagery, displaying images that simulate flight, landings and take-offs. In a simulated landing, the computer causes the ground image to appear to loom up towards the pilot. The speed of the computer's update rate gives the trainee pilot the impression that there is no time-lapse between the movement of the controls and the change in the simulated ground s/he is looking at. For example, the head movements of a pilot are tracked and monitored, the computer working out what the pilot should be seeing in the worldspace and displaying the appropriate view in a few thousandths of a second).

Sutherland and Evans' prime concern was to make simulators run faster and to develop custom computers which could process simple shaded surfaces in real-time. Thus there was little aesthetic consideration given to the imagery. This was the beginning of what would become a huge industry, one which held grimly to narrow instrumental goals until very recently. "Bigger, faster and with more polygons" became the mantra in flight simulation for civil and military aviation.

The economics of computer graphic research

The concerns of researchers in computer graphics flight simulation have had a significant effect upon the development of computer graphic image making as a whole. The constant striving for faster machines that will allow more complex objects (more polygons) to be used, and will process data more quickly, has resulted in minimal funds being allocated for other areas of research in computer graphics. This channelling of resources is a commercial necessity if one company is to advance beyond its competitors.

Though the bulk of the funding money goes directly to flight simulation, the research funded by it influences a wide range of applications and the results are often adapted to create PC software. Take a company with an interest in flight simulation like Thompson Avionics, or a government-funded military group like NASA, introduce a small company such as VPL run by visionaries with technical know-how like Jaron Lanier, and the result can be the development of innovations like the Virtual Reality glove and the head-mounted display. These inventions, which are already appearing in high street entertainment arcades, are the direct result of investment by the military and big corporations.

The research, the function and the look

The funding of research has a direct effect upon the computer artist who usually relies on new developments in the industrial and commercial sector gradually filtering down to the independent user. Research and development in the commercial sector has had positive results for artists, resulting, for example, in the advent of user-friendly systems like the Apple Macintosh. But the channelling of research funding effects more than the *technical* constraints of artists using computers, whose interests in the direction of technological advance often conflict with those of commercial image makers. Ultimately computer graphics research influences the “look” of the artwork made with computers.

In three-dimensional computer modelling the appearance of objects has altered greatly over the last three decades as a direct result of such research funding. The first important change came from the MIT laboratory and centred around a technical capability to remove hidden lines from the view of the wire-line objects

(previously the only views available). The military's eagerness for believable simulations of flight drove the research further. Next came the creation of solid-looking objects, of simple geometrics which originated from MAGI in the form of a system which enabled the construction of complex objects from simple building blocks of spheres, prisms and cubes. A contrasting solution came from Utah, objects being shaded according to the facets that made up their wire-line structure via shading algorithms. Henri Gouraud gave this type of shading a smooth appearance with the development of functions which blurred polygonal models.

The plastic and geometric look of computer graphic images of the late seventies and early 1980's was dismissed by many artists who wanted the variety of texture and non-geometric shapes. Industrial designers felt differently, the computer was imitating some of the visual effects that they had been creating with the airbrush. It was the desires of such commercial users that fuelled research into simulating different surfaces, for texture for artists was not at that time a particular priority. To begin with, it was not possible to generate chromium-like surfaces, but these were soon to become technically feasible. It is possible to make some tentative generalisations on the relationship between the "look" of computer images made with three-dimensional modelling techniques, and an associated and implicit aesthetic. Though this aesthetic is not yet canonised, it does seem to be agreed amongst the avant garde.

The plastic, shiny look which initially was the only type of surface available (due to its relative computational cheapness) has become synonymous with computer graphics. These scenes are often produced by mathematicians who have mathematical models for basic objects such as spheres, cubes and simple

replicated patterns like chequerboards: such objects and shapes appear frequently in computer graphics research and their data is readily available. Along with the Utah teapot and the VW Beetle (see Figs. 28 and 29) these have become computer graphic icons. Computer graphic icons, although historically necessary, went beyond their status as developmental norms, and achieved cult status, thus creating a corresponding aesthetic and defining the taste by which they were to be enjoyed. The plastic and shiny look became, almost by default, aesthetically “fashionable”. The spread of computer images via commercials and through computer magazines and games had the secondary effect of democratising the aesthetic into popular culture.

The implicit aesthetic values have by now achieved a high degree of visibility - we see shiny spinning logos innumerable times every day on television, but “the look has also migrated to shop signs and magazine advertisements. The taste has even transcended the technology; recent BBC2 logos were produced without computer modelling, but self-consciously adopt the plastic aesthetic, emulating the clean, plasticised appearance by using water and objects coloured in slightly different tones of the same colour.

Development of the computer graphics look

Platonic beauty and the computer image

Computer generated images exist against a background of aesthetic history, the influences of which remain extremely powerful. Any “new aesthetic” that may be

associated with computer graphics relates to (and reacts against) established aesthetic theories. As any “new aesthetic” must establish itself in part against this history, some of the arguments will necessarily be conducted in its terms.

Socrates defined objects as beautiful (which is an approximate translation of his term *kalon*, meaning fair or fitting as well as beautiful) if they were well made to fulfil their function. Later he psychologised this definition by adding that an object of beauty gave beneficial pleasure. Computer graphics images, when reflective of mathematical formulae, such as fractals, match the first criteria in so far as their fittingness is apparent as visual representations of the underlying equations. Similarly, different renderings of databases like the Utah Teapot or Volkswagon Beetle are pleasing accounts of the algorithms that generate them, but they are also pleasing objects d’art in their own right.

The glossy, smooth look of much computer imagery is computationally easier and cheaper to produce than creating natural variation and texture and there is an admitted tendency for the acquired taste involved to turn a necessity into a virtue. Early computer graphicists were trying to replicate mathematically the optical phenomena arising from predictable relationships between lighting, surfaces and reflection (Phong, 1975). The art depended on the development of digital models for ambient, diffuse and specular lighting effects. The simplest implementation of these lighting models in a rendering system produces surfaces which closely resemble plastic, although more elaborate rendering methods, involving considerably more computation, were developed for metallic and dusty looking surfaces (Blinn, 1982). It is because it is simple to produce that the plastic look has become a standard feature in the iconography of computer images.

The surrealist world of computer graphics

This look, and others which followed it, were attempts to mimic the appearance of surfaces from the real world, but in an electronic environment which retained few of the physical characteristics of the outside world. In the computer worldspace, objects have no weight and are not necessarily subjected to gravitational forces which might affect their shape or distort their surface. Although such effects in principle might be programmed, there was no pressing impulse to choose this path. Objects modelled in a computer have equal non-chemical states; there are no solids, liquids or gases, only coloured pixels arranged according to algorithms describing their colour in values of red, green and blue. To model computer graphic imitations of liquids and gases is particularly difficult, as the attempt depends upon manipulating mathematical data to imitate form by the deployment of coloured light. To simulate a liquid's movement, rippling and reflections demands highly complex algorithms which are time-consuming to process and render. There are similar problems with gases which drift in a haphazard way.

Within the computer graphics world, objects are no longer bound by the physical constraints of the real world. At times it appears as a fantasy world in which objects, such as ray-traced spheres with chromium-like surfaces, appear to float weightlessly above chequerboards. There is consequently often a "surreal" look to computer imagery, which capitalises on the ease with which computers can join and combine inappropriate objects. In the computer world there is generally none of the depth of field associated with photographs (caused by the iris), so particular areas of the image are not more focussed than others - the background of an image rendered by the computer can be as sharply focussed as the foreground.

Idealised simplification

Within the field of three-dimensional computer graphics, where images are projections from 3D models, visual detail is created using one basic building block, the polygon. This is similar to creating an image with mosaic tiles, the detail being restricted by the size of the basic building block. Each polygon takes up some of the limited space in the computer memory, thus restricting the number of polygons which can be used in the modelling of objects and scenes. As a result, the computer scientist tends to create idealised simplified models of real objects which smooth out natural variation in shape and texture, reducing the object to as few facets as possible. The fine art painter also idealises representations of the world and deploys various styles and techniques to this end. Both artist and computer scientist need to imply detail in selective areas, without literally building it up atom by atom. Turner's skies were not represented particle for particle but are stunningly evocative nevertheless. Similarly, new developments in generating convincing foliage for simulations rely on the detailed leaf structure only being employed in the foreground while a more impressionistic techniques, using less polygons are placed in the distance (Selley, 1991). This computer modelling technique was inspired by techniques developed by the Impressionist painters.

Since the surfaces of three-dimensional objects tend to be simplified, there is a tendency to avoid dirty-looking objects which would be complex to render, so objects typically conform to the ubiquitous plastic and shiny look. In the area of fine art painting there was a movement that was aptly named photo-realism in the 1970's, which was characterised by artists working closely from photographs to

create images of chromium caravans and other highly reflective surfaces. Not long afterwards it was possible to discern a corresponding interest amongst computer scientists who aimed to simulate the optics of reflection and refraction in glass and chrome in order to produce a similar effect of depth of field. This apparent traffic across media boundaries charts the quest for a kind of realism, an attempt to record and imitate events convincingly. The aim of accurately recording of an event is evident in photo-realist painting, paralleling what is held by many to be the definition of photography.

Photo-realist painting aestheticised the study of reflective surfaces and in the process legitimised photographs of similar subjects. In developing rendering techniques which produced reflective surfaces, the computer scientist may well have been responding to these shifts in taste within the art establishment. Equally, such developments may have been prompted by an attempt to provide a service to manufacturing industry at a time when the car, caravan and aeroplane were enjoying increased popularity in the post-war boom. Industry was looking to computer technology to make designing and modelling their products more cost effective and “high tech” in appearance. The fact that this coincided with photo-realism (itself a response to the consumption of expensive high tech commodities, epitomised by the chrome of the fender and the reflection of metallic paintwork) illustrates the complex process of response and reaction which is constantly occurring between commercial concerns and artists.

The computer screen

The screen is the most common interface between artist and computer. Regardless of the final form in which an image is output, it is typically designed on-screen.

The screen differs from other sites of interaction for the artist; unlike stone, clay or wood it does not yield, and cannot be shaped or made to provide any kind of tactile feedback; the screen and the monitor that houses it are constant reminders of the “otherness” of the machine; when you finish for the day and switch off the power the screen is still there, but the image is gone, and if a technical complication arises it may not be possible to retrieve it. It is as if the image *belongs* to the computer in some way that is outside of the artist’s control.

The physical characteristics of the computer screen have an important role in the way in which computer images are viewed. When computer images are viewed on screen, rather than being printed out or photographed, their interpretation is significantly affected. The image appears to float behind the glass of the screen, and is seemingly not located in any particular point in space, while the physical distance between the operator and the monitor emphasises their separateness; it is like

“Alice through the Looking Glass. The idea of the looking glass and the screen is the same. You are looking through into something else, it doesn’t matter if its a screen or your imagination. The screen is the interface between man and machine.”

Edwards (1991) Transcript of speech at ICA 1991

If the image is larger than the screen size, the operator cannot step back from the screen in the way that a painter can step back from the canvas, to view the whole display. The artist’s view of the images is therefore limited by the screen, but the images are not *on* the screen. The fact that screens are often smeared and can have distracting reflections from light sources in the room or of the person sitting in front of them, supports the feeling that the computer is

“...just a mirror; you’re just talking to yourself all the time.
There’s no one on the other side”

Stiller (1990) p.36

Screens have variable brightness, contrast and saturation controls which result in a large degree of variation in the appearance of any given image when viewed on different monitors. These variations occur because colour images are produced on the screen by red, green and blue phosphors which glow on the inside of the cathode ray tube. Manufacturers use different phosphors so that the same voltage drive from the same video card will produce different colours with different monitors.

The Film and Video Umbrella has put together a programme of video pieces which make up an “Art and Science” collection, comprising works by a variety of artists using diverse techniques. These range from Sinclair Stammers’ microscopic recordings of crystalline forms in his Optical Experiments series, to the use of television graphic equipment like Harry and three-dimensional computer graphics in Stakker’s Eurotechnic, to the work of William Latham, such as The Evolution of Form created with high powered computers at IBM. The works came from a variety of sources and when shown at The Whitechapel Gallery in London in January 1992, monitors were used for display. I had previously seen a screening of the same Latham pieces as part of his talk at the ICA in late 1991. Then the original film footage of the sequences was projected giving the audience the advantage of seeing in minute detail in stages of transformation of the computer rendered and animated forms. The gradual changes in colour and the small components that made up an object were sometimes unclear when the sequence was viewed on videotape, due in part to the small size of the screen and in part to the decrease in resolution.

Interfering with the screens

As Benton observes, the future can be relied upon to downgrade the achievements of the present into low-tech:

“100 years from now people will wonder how we put up with two dimensional pictures and screens for so long.”

Benton cited in Haber (1988)

Stephen Benton is an MIT technical guru who for some time now has been predicting the advent of holographic screens, and he believes that from these it will soon be possible to out put hard copy in the form of holograms from a printer attached to a computer. Though these possibilities are technically out of reach at the moment, the screen is a constant focus of attention not just because it contains images but because of its own identity - it is seen as a window, a veil, a mirror and a frame for images. Hologram technology would certainly enhance the sense of a computer image “floating in space”, while increasing its tactile quality.

The medium of VR offers an alternative site of interaction to the screen. Like in an installation, the audience can be immersed in a virtual artwork. Currently the headsets worn by people to experience VR contain low-resolution liquid crystal displays which reduces the image resolution.

The quest for “realism”

The aesthetic value of the sublime

In the late seventeenth century there emerged a new and sweeping feeling for nature and natural beauty. Alongside art, nature became a subject worthy of aesthetic contemplation, and in pious versions this resulted in God being perceived as the ultimate artist, the creator of nature. With its vast scale, sweeping landscapes and impenetrable mountain ranges, nature partook of, and indeed largely sustained the aesthetic of the sublime. The overwhelming sense of overpowering scale felt by those contemplating nature was thought to prompt consideration of the Infinite God who had created it, allowing religious experience to share blurred boundaries with the aesthetic sublime. In contemporary Western societies, ideas of nature as sublime have eroded somewhat as we have been able to “conquer” even the highest peaks, and have lost most of our opportunities to view vast expanses of landscapes through the expansion of building and an increase in air pollution which renders the horizon less visible. Paradoxically computer simulations of nature (see Figs. 30 and 31) vilify our current dilemma allowing us to experience a nostalgia and yearning for the sublime, unconquerable nature. Human beings simultaneously revel in our ability to reconstitute an “improved” awesome wilderness through digital technologies. Jurassic Park was able to capitalise on this as a box-office proposition.

This dilemma/gestalt transcribes aesthetically as a subtle but persistent dis-ease with computer simulations of nature, for all their evident attention-grabbing qualities. But there is also a parallel rejection of technologies whose “taste” is

founded on classical paradigms of nature and the sublime, and who see computer simulations as best directed towards taming sublime nature to new notions of proper mathematical order. Another side to this gestalt is found in the aspirations of producers of simulation, to borrow canons of taste that will, mechanically as it were, beautify the computer image itself. Rather than cultivating an opposing “taste”, these computer graphicists share Shaftesbury’s belief that beauty and nature are connected.

Through the dissemination of fractal images and the greater realisations of the aestheticising implications of chaos theory, there is emerging a renewed interest in detail, and a sense of the “sublime” having its equivalent in cyberspace - the unexplored, unconquered and unknown realms of the digital world of electronic signals, networks and remote human presence. Although Shaftesbury connected the sublime with the overwhelmingly large, the shift of taste which I am attempting to encapsulate is less a matter of mood in the presence of nature that belittles humanity, and more an intellectual response to theories expounded by physicists like Stephen Hawking, who see a kind of sublimity in the microcosmic world of particle systems. It is the very small and the very detailed which now prompt the “great thoughts and passions” as man is challenged by the scale of things, just as vast expanses of nature once did for Shaftesbury. While Shaftesbury’s sublime was too big for us to grasp comfortably, Hawking’s is perhaps too small.

The quest for realism: imitation

Appearance and reality, the relationship between the image and that which it represents, has long been a subject of interest to artists, scientists and

philosophers. “Mimesis” as a term first appeared in the fifth-century applied to musical imitation of other sounds, like voices and actions in drama. Its range of explanation has subsequently been extended to the visual arts.

According to Plato, all art is mimetic and imitative, qualities by which the “arts” can be differentiated from the less prestigious “crafts”. Plato’s terms “mimesis” demotes imitation or representation in art; the associated terms “mexthesis” (participation) and “homiosis” and “paraplesia” (likeness) suffer in their English translations. Certainly mimesis, as Beardsley points out, is a notion elusive in its complexity:

“Not only are objects imitated by pictures of them, but the essences of things are imitated by names, reality by thought, eternity by time. The musician imitates divine harmony, the good man imitates the virtues, the wise legislator imitates the Form of the Good in constructing his state, the god imitates the Forms in making the world. ...“Representation” is possible *as a translation of mimesis*, because it has several senses: the senator represents his constituents, the picture represents the object, the trademark represents the product. “Mimesis” perhaps carries with it a stronger notion of copying, of being modelled upon; but this is present in “representation” too - even the senator, when truly representative, may be said to mirror in his vote the will of those who put him into office.”

Beardsley (1966) p.34 my italics

The passage above implies that the imitation does not have to be slavishly literal. Representation can be symbolic or allegorical. The value that we have afforded “mimesis” in art can therefore be applied equally to work of artists like Mark Rothko who could be said to have achieved mimesis of meditation and harmony, as to Andy Warhol for the representation of his soup cans. If there is a sense of pleasure and unease surrounding mimetic art, Aristotle may provide some insight into the pleasure. He suggested that imitation is natural to human beings and that the recognition of imitation is pleasurable even if the object of the imitation is not

in itself pleasant, that the pleasure comes from recognition which infers that the object and the imitation are identical, and that we learn from it. The subject of the imitation may not give knowledge in itself, since it is the act of recognition which is important.

There is unease in recognising that which we find uncomfortable, and ironically in recent years there has been an increasing unease surrounding mimesis and authenticity. As works of art are seen more as financial investments, the identity of their creators becomes paramount. A successful imitation loses value when its found not to be the original, the pleasure of recognition is squashed by the realisation of misattribution. A work losing its provenance loses its value, without changing itself, if the link back to a required authentic personality/genius is severed.

Perfecting nature?

In The Sophist Plato gives a more precise meaning for imitation. He compares the production of actual objects and of pictures, seeing the production of pictures as the more imitative (Beardsley, 1966). An important attribute of an imitation is that it does not express the entire reality in every detail, since if it did it would be another example rather than an imitation. An imitation may be a true likeness (an *eikon*) or it might be a copy of the way an object appears from one viewpoint (a *phantasma*). To make something resemble something else usually requires a degree of distortion, as when perspective enables a painting to resemble a road by distorting its dimensions to accommodate the effects of situationally-specific viewing. Plato also notes that the possibility that distortion might produce an improved imitation, in which the representation conforms to certain valued

criteria better than what it ostensibly imitates. Court portraiture is an almost perfect example of an art form committed to this principle. By way of contrast, the illusionist can choose between pleasure and truth in order to please the beholder (Beardsley, 1966).

Computer graphics and commercials are driven by fashion as it is interpreted by the directors. At the moment the trend is for mixing live action with computer graphics seamlessly. The most successful use of computer graphics results in their input not being recognisable and can be seen in the milk advert where video sequences of a milkman on his round are fused together with computer graphic milk bottles which dance alongside him, these *phantasmas* improving on the mundane objects which they imitate, as the milk bottles gleam and dance to the spotlessly clean doorsteps. The video paintbox can clean up a domestic environment faster than any housewife.

Photography and realism

The concept of mimesis was forcibly revisited in the wake of the aesthetic challenge posed by photography, self-evidently paradigmatic as an imitative art form. The argument that digital technology's capacity to change an image, has undermined the "authenticity" of the photograph as an objective portrayal of reality has a hollow ring to it. Firstly there is the choice of what to photograph and what not to, although in the case of war photography the military may censor access to areas or stage approved scenes. In any event the photographer's choice of camera angle, lighting etc all contribute to the creation of mood and meaning. Since the beginnings of photography, the photograph has been altered in the darkroom using techniques from cropping and burning in areas for accentuation,

to combining different images to make composites, to adding or removing figures from photographs when, for example, their presence might cause political embarrassment.

The language of genetic engineering

While some practitioners focus on creating an idealised, “perfect” nature, others study the dynamics of natural phenomena and attempt to incorporate these into their programs, assuming the role of the genetic engineer of the computer world, distorting servile mimesis not only by plagiarising the natural world, but actually mimicking natural dynamics like evolution and natural selection.

William Latham’s art plagiarises the natural world, introducing “branching” functions to his programs, creating mutations that increasingly alter his objects as they evolve over generations. Latham describes himself as “the artist who controls natural selection”, his very language mimicking that of the biologist or genetic engineer. His programs, which parody the natural world, have functions called “breed, random, good, bad, kill, marriage”. Verostko describes his software art as genotype and the resulting paintings as epigenetic,

“Although each work is one of a kind it does belong to a family ...the software, Hodos may be viewed as a genotype, because it is the code for how to make the work ...The potential for crossing families of different artists opens the possibility of the hybridisation of form and eventually of a genealogy of form.”

Verostko (1990) p.17

Margeret Benyon’s interest in “the shared member” is seen in her holograms of composite images, which result in a

“bizarre sharing of bodily parts on multi-exposure ...This phenomenon can look like a genuine genetic mutation.”

Benyon (1988) p.497

Using computer generated objects in combination with human bodies through multi-exposure is now possible, and through these techniques we can begin to visualise evermore vividly, the cyborg. We can produce images of such fantasies which are compellingly three-dimensional, and through video-holograms it will become possible to see these cyborgs move. It is not such a jump from the images which already populate hairdressing magazines; here there are adverts for computer programs which scan in a customers facial features and then show the face with a variety of different hairstyles, so you can see what you might look like before succumbing to the scissors. It is not just in producing science-fiction-like images of human-machines that artists using computing technology refer to cyborgs and digital prosthetics. The relationship between artists and computer is frequently becoming so intertwined that the two form a kind of cyborg entity.

The cyborg artist: simulating manual techniques with computers

Some functions inherent to widely available painting software, like the ability to cut, copy, paste and distort are being used in the production of computer based art works to emulate well-established genres like Cubism and Surrealism. By contrast, some artists are programming computers to produce images which they feel are not satisfactorily produced by commercial software. They are adapting existing software, and developing new software, in order to create the images they want. Artists working in this way, and those working in conjunction with computer scientists, have learnt to write computer programs in order to generate

artworks that look remarkably like the ones that they made by hand before they worked with computers. Roman Verostko uses the term *software art* to describe programs

“written or modified by an artist to carry out an art concept”

Verostko (1990) p.18

He goes on to describe his “personal expert system” which is a combination of “software art” and hardware which enables the processing of “unique art concepts”. Verostko’s goal is to encode the procedures which produce art in a piece of software. The German science fiction writer and computer graphicist Herbert W Franke has similar aims, to decipher what makes something more than beautiful - what makes something art - and to formulate that in a mathematical equation. The idea that art can be produced by following a mathematical formula (which implies that a machine might do it as well, if not better and faster than a person) is anathematical to those who believe in the sanctity of the artist as genius, an archetype associated with the irrational, the highly intelligent and the crazed. Mathematical formulas are the polar opposites of the genius artist. The artist Verostko occupies the middle ground between these two positions, basing his software design on paintings that he has created by hand, transcribing his manual process to an electronic one. He treats the computer as a labour saving machine, by which the artist views the results and selects and adjusts the program accordingly. The success of this program is judged by Verostko to be when an outside viewer might easily interpret a series of paintings

“as a natural evolution in the hand of the artist”

Verostko (1990) p.21

Using computers to create images which are manually unattainable

Where Verostko has programmed to simulate the painting technique he had previously executed by hand, William Latham has employed the computer to sculpt, in three dimensional computer space, objects which he would be unable to literally carve, build up or mould. He uses the computer to create

“photo-realist representations of objects that don’t exist ...I began using the computer as a tool - now its like a creative partner”

Latham (1991) ICA

While he is using computers to simulate objects which are impossible in the real world, Latham’s use of the term “photo-realism” is an indication of his desire to make these objects appear “real” and believable, to convince his audience that such objects might exist outside of the computer. Like Escher, Latham uses familiar building blocks to produce impossible images, part of their resonance lying in our struggle to make sense of them in our three-dimensional space. Though Latham describes his computer(s) as partners he is quick to retain his authority over them. As he describes his working process it is apparent that he retains control in a variety of ways, not least by setting the parameters within which the computer can create infinite numbers of objects. These parameters describe and limit functions like branching, splining and colour. Latham compares parameters to genes, and simulates the mutation of genes by changing the numbers that make up the parameters. His second controlling device is the interactive program which allows him to set in motion functions which he has emotively named “breed”, “random”, “good”, “bad”, “kill” and “marriage”. Using this program Latham can intervene in the mutation of forms by defining a structure and then subjecting it to one or more of the above functions/mutations.

After control has been exerted Latham has the ultimate power: he chooses whether a form is “good” or “bad” and whether to “kill” it, or “marry” two or more forms together. Watching the animated sequences which show the “evolution” of his objects, and listening to descriptions of his working process, which are interspersed with terminology reminiscent of the biology lesson or the genetic engineering lecture, one is left with an impression of Latham as some kind of Dr. Frankenstein, obsessed with combining elements from different forms and imbuing the inanimate with simulated life.

The title of “cyborg artist” would seem appropriate for Latham, since his images would be impossible without the computer and could not be produced using any other tool. Equally the images could not be produced by the computer alone, the raw data would not suffice because decisions which are crucial to the development of an object depend on a visual rendering which the artist responds to subjectively and as a consequence interrupts the program. Speaking at the ICA, Latham stated that he was interested in programming a second computer to run in conjunction with the one which generated the three-dimensional forms. The second computer would be programmed to make the decisions currently made by the artist, it would control the functions of “marriage”, “kill”, etc. This would entail translating the artist’s aesthetic judgements into mathematical parameters, which would probably be a complex procedure, but the second machine would still be controlled (via the programming and choosing of these parameters) by the artist. The artist would be one stage further removed, yet would maintain authority.

Computer controlled art making machines

Images which are formed inside computer space and displayed on screen are the most common image that we have in computer art. These images can be printed straight from the computer in full colour, transferred onto colour print or transparency film, recorded using video tape or cine film to provide a more tangible physical version of the work which can be displayed without the use of a computer and monitor. The computer driven robot can be programmed to mechanically create images using traditional media such as brush and pen.

At the Japanese Robot Exhibition at the Science Museum in 1991 the calligraphy robot painted Japanese characters with a fine brush dipped in black ink. The robot looked rather incongruous as it was “dressed” in a red and white Japanese costume like the one worn by a row of dancers that make up the dragon in a traditional dragon dance. It seemed as though in assuming the role of the artist, the non-human form of the robot’s machinery had to be hidden. At the same exhibition the drawing robot, wearing a beret to symbolise artistic ability, interpreted the image of a sitter which was fed into it via a video camera. The video signal was processed and the robot sketched a portrait which was then printed out and presented to the sitter. The image appeared to be based on the light and dark areas of the input signal, shadows along the hairline and the relative darkness of the eyes against caucasian skin causing them to be clearly drawn by the robot. While I was at the show I did not see any portraits of people with black skin, so it is not possible to know if the processors were sensitive enough to decipher less obvious contrasts in tones and make the robot capable of producing equally recognisable likenesses to sitters with dark skin; if not, then the robot/artist would also be continuing the Western tradition of making portraits of

only the white middleclasses (it was expensive to get into this exhibition).

With the development of artificial intelligence, resulting in the manufacture of computers which have the potential to learn and change their responses accordingly, artists like Verostko may find that within their lifetime such a machine is developed which they can program, or link to their art-making machines. Artificial intelligence may advance to a degree whereby aesthetic parameters, the elements of what it is that makes an image “artistic”, can be fed into these machines which will then evolve artworks without the need for human intervention. Artworks may be entirely generated and evolved by computers, the creative process in these instances might be deemed to be in the writing of the software that drives the computer to produce the images.

For a long time computer science and mathematics programmers have been stating that programming is creative and artistic, but they have largely been ignored by the art world. As programming is taken up by those artists who already hold positions within the art realm, so it is an activity which can begin to be accepted as “creative”, this has greater effect than computer scientists have had by arguing for the boundaries of the artworld to be shifted to accommodate them. This realisation could lead to a greater acceptance of the similarities between art and science, the creativity that is inherent in both, and a re-merging of the two.

“Aura”

Mechanical reproduction of art images has been said to contribute to their loss of aura. This loss is partly due to the detachment of the reproduced object from the domain of tradition (Benjamin, 1970). Aura is inseparable from the value of

uniqueness; a value which has its roots in the ritualistic function of early art - the sacred role of the cave paintings, statues (like that of Venus) and so on. Benjamin argues that there is a cult value associated with owning art objects/ritualistic objects, which depends upon them being unique, once they are reproduced they cease to perform a ritualistic function and become political.

Uniqueness

Even in the age of mechanical reproduction, it has continued to be the uniqueness of an art object that imbues it with value. Uniqueness is a significant factor both in art fetching ever greater prices in the auction rooms and commanding greater admiration in the gallery. Techniques and mediums like etching, printing, photography, film and video form part of the lineage of the mechanical reproduction of art works, of which computer technology is part. The material form of the artwork produced on a computer is elusive and easily reproduced:

“the essential objection to the new medium is that there is no profit in it for the gallery owner.”

Owen (1988) p.14

Keating’s convincing copies of famous and highly valued paintings by a variety of artists were an embarrassment to a system which had assigned such value to the so-called unrepeatable act of genius which resulted in each unique “masterpiece”.

Aura

Notions of “aura” are strongly aligned to the uniqueness of an art piece and its

authenticity. It is not surprising that paintings (such as those copies produced by Keating) once loved, valued and revered could overnight lose all their charm, when it was discovered that they are not the originals; and are neither authentic nor unique. The mechanical reproduction an art object is held automatically to erode its aura; a print of a well known painting can never capture the whole sense of its subject, and its aura is thereby diminished. On the other hand photographic and digital processes such as enlarging and sharpening can reveal elements which in the original image might be invisible to the eye.

Loss of aura through despecialisation

The computer is seen as a particular threat to the aura of artefacts, not only because of the challenges to authenticity and uniqueness, but also because it is felt that it undermines the value given to the specialised skills of traditional artists. The expert or specialist has long been valued over those with a wide general knowledge, fine art degree courses still largely encourage students to specialise in one area whether it is painting, sculpture or media rather than working across these technical areas. Specialised techniques like those of the painter, draughtsman, typographer and airbrush artist are presented as options in many computer packages. This reduces specialised skills to that of an option (Wright, 1989) and this is linked to a loss of “aura” in the images produced on computers,

“the loss of specialised craftsmanship carries over to a loss of aura in the image itself.”

Wright (1989) p.50

The computer user does not need to spend hours arduously studying perspective

because there is probably a function within a computer painting package which will approximate it for her/him. The same goes for the study of light and shade in a three-dimensional environment - a computer three-dimensional solid modelling package will work out all the lighting for you, all the user has to do is to make and position the objects and the lights (an arduous and demanding task in itself). What critics like Wright seem to ignore is the specialised skills which are needed for artists to use computers in the first place. In addition to needing basic computing skills, many painting and modelling packages are highly complex, requiring hours to learn and longer to adapt (and in some cases unlearn) in order to get a basic program to produce a visual effect it may never have been designed to facilitate. A colleague on a computer graphics course spent hours and hours trying to produce a spotlight effect in a three-dimensional modelling and animation package, eventually he built a kind of false ceiling in his computer scene, cut holes in it and positioned his light source behind the holes to get the effect he wanted. This is the type of skill necessary to get the most out of computer software.

The photographer and computer artist Phil Wostenholm, who now works predominantly with Amiga computers, feels that the computer imparts an aura rather than depletes one. He shares my belief that computer packages which present specialisations as options within one program could be seen as symptomatic of the move towards a reintegration of different techniques.

Like many artists who are using the computer as the primary means of producing their art works Wostenholm has experimented with images, producing and saving several versions of an image en route to the one which he feels is most successful. This option is another of the computers functions which has alienated certain art

critics, and goes further to challenge ideas of authenticity. If authenticity depends to a degree on the unique position of an image in time, then the chance that more than one version of a piece (each of which may differ only very slightly) may exist throws open the question of which version is the most authentic. Very quickly the value of authenticity is collapsed.

Challenging the prestige of ownership?

The fetishisation of art objects through ownership is not necessarily dispelled by the production of many mechanically reproduced, non-unique versions. The computer as a tool denies the need for traditional specialised techniques and supports plagiarism, multiplicity of sources, technique and reproduction.

Computer networks and satellite TV could offer an accessible means of exhibition/ownership to counter the gallery system, allowing anyone with a modem to import images into their homes/work places and record them. In Holland cable TV are transmitting soundworks and artworks more regularly as electronic art lends itself to the broadcast media that are part of the history of magnetic recording. As telephone networks become faster the cost of importing images across modems will become cheaper increasing accessibility further. The art distribution system (the gallery) initially responded to this new means of production and distribution by attempting to devalue the art made with computers. As the production continued and expanded the response by the established art world has been to try and contain it.

Benjamin argues that objects lose ritualistic symbolism through mass reproduction, and on the surface this proposition seems reasonable, but alternatively the ritualistic value of, for example, mass produced rosary beads if

anything enhanced rather than reduced by their multiplication, given the social context in which they operate. They may not hold particular value attributed to a relic but they nevertheless retain their symbolic power en masse. The same might be said of posters of fractal images or record sleeves produced by artists using computers, which equally denote and vivify a shared belief system.

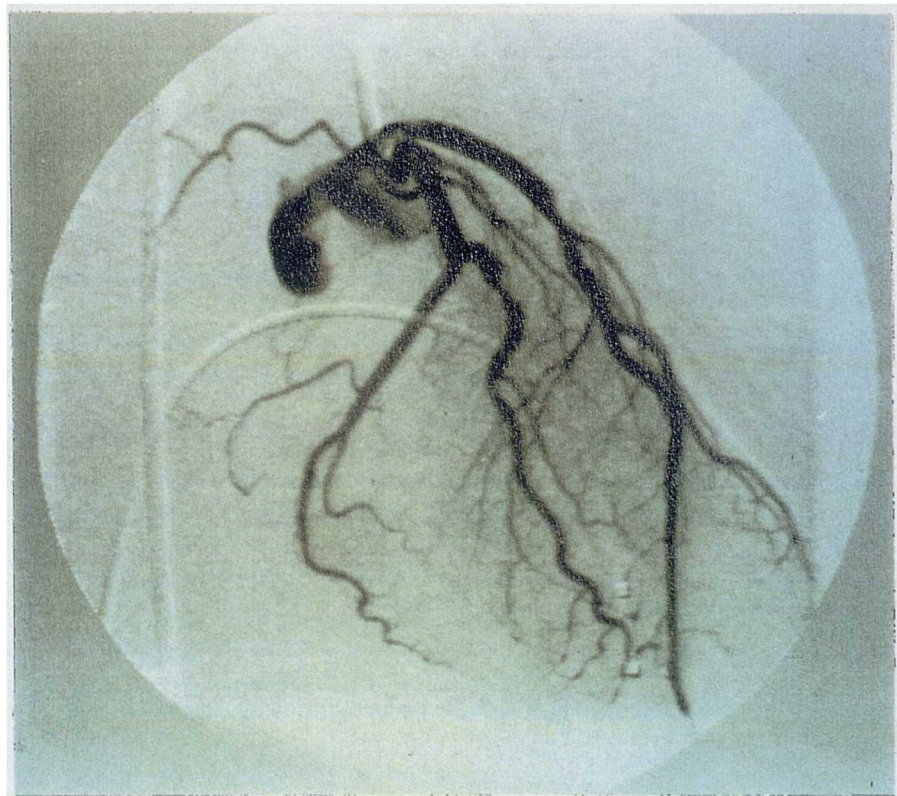


Fig 23: An Angioplast image at high resolution.

CONCLUSIONS

Clearly a thesis of this kind requires, at least some tentative, statement of conclusions. Unlike hypothesis testing research (even where employing the looser so-called “pedagogical hypotheses” of action research), or quasi-experimental research, the kind of research reported here is likely to present its conclusions as a series of interim statements, contextualising them as an on-going part of the wider feminist intellectual project. Nevertheless, conclusions are offered in four areas; (1) summarising my views at the end of the thesis concerning the interrelatedness of the issues discussed, (2) canvassing particular conclusions in relation to the difficulties examined with respect to electronic imaging in art and design education from the gendered, “pedagogy of the oppressed”, perspective of “feminist standpoint theory”, (3) seeking to adjudicate, very provisionally, some of the questions raised concerning the possible emergence of a new aesthetic, and (4) bringing the exercise back within my own experience as a woman video artist by relating how the theoretical and practical concerns examined in the thesis have directly influenced my work as an artist.

The interrelatedness of the issues

It will be immediately obvious to the reader that the structure of this thesis took a number of calculated risks in departing to some extent from the conventional narrative or analytical sequences that usually characterise work presented at this level. To some extent the issue was the one referred to in the body of the text, raised by Chris Argyris and Donald Schon in relation to participatory action research (see chapter six of William Foote Whyte (ed) 1991), the “fundamental choice that hinges on a dilemma of rigor or relevance”. This is not to declare a lack of concern for rigor; far from it - appropriate standards of rigor have been applied as far as possible. It was simply that the complex configuration of issues addressed were messy, not easily brought to cognitive order, incomplete, and

carrying difficult and contested implications for action. Having been attracted to this kind of research problem, it seemed necessary to seek to approach it within the terms of its own logic. The structure of explanation has also been allowed to reverberate and interpenetrate, not unakin to the parallel networks of hypertext, although the comparison could be a misleading one and should not be pushed too far. I feel that I have sufficiently indicated in each of the chapters how its focal concerns widen out and interconnect with the other discourses being canvassed, but it would be dishonest of me in this conclusion not to attempt a few tentative cross-discourse generalisations. In the nature of things, these must be treated as illustrative and in the spirit of hypertext, the reader is also invited to generate his or her own. Given this exemplary patterning, five intertextual generalisations appear about right.

Generalisation (1) -

The computer revolution is here, and here to stay. It is forcing radical rethinking of a number of cultural assumptions and already reshaping educational philosophy and provision, and not only in those areas that superficially appear immediately relevant to it. There is a saying that those who ride tigers go where the tigers want to go, but if we are going to avoid the technological determinism that would leave us passive, and to some extent baffled by the present and coming shifts, some kind of cross-disciplinary and holistic mapping is required. Because all of the genres are blurred and most of the discourses mixed, sufficient understandings to navigate the changes are likely only to come from what Clifford Geertz (1983) called a willingness to readjust the very basis on which the mapping is being attempted. If there are no settled conceptual apparatuses anymore, then shifting tastes, exploratory teaching and digital Utah teapots can

quite easily end up in the same sentence, as they do in the title of this thesis, which sees itself as a limited contribution to this imploding agenda.

Generalisation (2)

Although there is some general agreement about the bipolarity suggested by Marshall McLuhan (1962) in dividing print and electronic cultures, this has been overtaken by technological events as far as print production technology is concerned (in effect collapsing the two cultures into one), there is less realisation that the boundaries between the products have also collapsed. My argument is that there are at least two dimensions to this merging of territories; firstly intellectual domains are increasingly iconographised hypertextually as relational nets, rhizomal structures, associative linkages or whatever, almost as though the mental life suddenly found itself in league with the new technology. Secondly, itself associated with the blurring of genres, artistic practice has not only become more hybridised but is in some circumstances an adequate, if playful, model for serious intellectual projects. I found little difficulty in making what I felt to be illuminating comparisons between my “academic” cultural analysis and my “creative” work as an artist.

Generalisation (3)

Since the work of Joseph Schwab (1971), there is a better understanding that practical domains like curriculum need to develop a type of normative theorising that utilises “the unstable but usable arts of the practitioner”. The assertion being made here is that the field of study chosen exhibited the kind of complex interweaving of practical problems that could justify the adoption of a

complementary, multi-faceted methodology. In technology-based areas in particular, women working from a feminist perspective and seeking to establish practical policies as teachers and educational researchers need to locate themselves in relation to a variety of discourses as a means to map a complex terrain. Since the area is characterised by alternative and competing voices, appropriate institutional learning will need to celebrate the autonomy of the learner.

Generalisation (4)

The particular example of colour theory showed up what I take to be typical problems in translating a complex knowledge network, itself with internally diverse principles of organisation, onto a computer. Increasingly education is likely to face mixed mode and modularised subject matter in which different learning styles and approaches mix and meld with distance learning, studio based work, guided individual instruction, computer aided learning packages etc. These developments raise questions not only of course design but of their pedagogies and the characteristics of the milieu, matters which prevent the iconographies from being perceived as naively representative of their domains and force other considerations into the frame.

Generalisation (5)

Electronic media is indeed at a cultural cross-roads, and in a way that undermines the comfortable view that post-industrial subcultural values can be marginalised and treated as irrelevant, if not in school then at least in Further and Higher Education. The new digital technologies have brought into FE and HE a powerful

but dimly understood set of subcultural norms including hackers, cyberpunks, gnostic sects, cyberfeminists, technonerds, Virtual Realists, and serious readers of MAD magazine or the quasi-fascist fantasies of Judge Dredd. Teachers need in-service courses in polylogism and cyber-Esperanto if they want to avoid self-exclusion in their own institution through failure to master the technobabble.

There are also complexities surrounding the potentiality that the new technology holds for applications across a variety of cultural sites, not only in education but also in art, virtual reality, war, the entertainment industry, information technology and cybersex. A persistent argument in this thesis has been that these contexts bring their own emotional baggage, and associations from some of the other sites are quite capable of infiltrating the consciousness of those in education. One important detail in this general argument is the extent to which the genderisation of the technology has characterised all of the sites with profound implications for education.

A gendered perspective on electronic media in art and design education

Women artists are working within the same social and historical context, even though we may be seeking to subvert, expose and reclaim it. The discomfort that I have felt when watching videos like A 101 Ways to be a Sex Goddess are based partly in my awareness that the images are taboo, but more because of the way they reside on the boundaries between being transgressive, challenging, ironic and indulging old clichés and male fantasies.

My own feelings as a video artist producing allegorical statements, often around images of naked bodies, is one of considerable sympathy towards de Lauretis's account of the tensions in self-representations by feminists as arising from two

concurrent antithetical drives, the erotic and the ethical. Taken in isolation, the first might slide uncontrolled in the direction of the “dangerous, subversive excesses” of *Hustler*. However, she depicts the feminist erotic drive as ethically underpinned by a rejection of images of “powerlessness, victimisation, subjection, acquiescence, passivity and conformity”. At best its willingness to transgress taboos might be sensitive rather than gross, and I would be humble and pleased if my own work were to be thought of this way.

The environment of the television studio sanctions nudity in a way similar to the life-drawing room. In both spaces the clothed look at the unclothed. The gaze is sanctioned, which is in contrast to the setting of, say, the nudist camp. It has been noted that in the nudist camp staring is socially unacceptable (Weinberg, 1987) as is most body contact and photography (unless for a nudist magazine). In my experience the sanctioning of nudity by the professional studio environment was tempered by the dynamic of working with an inexperienced crew. Recording nudity was new to them and they exhibited many of the tendencies monitored by Marty Weinberg in his study of the behaviour of naive newcomers in nudist camps (in Weinberg and Rubington 1987). This research was conducted in a symbolic interactionist tradition and indicated clearly that in unfamiliar environments actors need to construct and defend definitions of the situation and the norms associated with them. These patterns of adaptation are dealt with more fully in the chapter, but an example may be useful here; when not performing their roles as vision mixers, lighting or camera-operators, the crew adhered to an unspoken rule of “not staring”. Other issues noted related to my change of role at these times, from subject to director.

The implications of the emerging new aesthetic

Of all the issues handled in this thesis, complications surrounding the emerging new aesthetic associated with electronic media is the hardest to map, although the history of shifts in taste with respect to other new technologies, like photography, have made clear some of the processes at work. Perhaps the soundest generalisation is that the aesthetics of the new technology will eventually contribute with its own terms to the new tastes by which it is enjoyed, although in the interim we are going through a period in which the new technology is imitating and appealing to some of the characteristics of the old. The main problem, in particular as perceived by women, is to put a brake on the current tendency for (male) techno-wizardry to masquerade as a surrogate aesthetic, dissolving all canons of taste whilst failing to work sensitively towards a futuristic humanistic alternative. One way in which I have sought to confront the issues of the new aesthetic is in my own work. Although video art, like all art, teaches by example rather than precept, these questions and the historical contexts in which they are being posed and answered have been directly addressed, as the chapter *Women Artists and Video Production as Action Research* hopefully made clear.

A feedback loop into art practice

Directly out of the exploration of themes dealt with in this thesis, my own work as a video artist has taken off in directions that it in the broadest terms have been fed by the research. This has not just been an individual set of preoccupations but has been shared with groups of practitioners. For example, the VR conference “The Body in Virtual Space” at the Institute of Contemporary Arts (1994) and the “Virtual Futures” conference at the University of Warwick (1994) both focussed

to some extent on gendered representations in art works involving the new technology, VR in particular. “The Body in Virtual Space” also gave a platform for a feminist deconstruction of Cartesian geometry, an issue of interest to many women using 3D computer modelling packages. The discussions around Cartesian geometry collapse two debates, one within a section of the art community, the other feminist geographers analysing identity politics and space.

At the time of writing, my major current video project is one that has been provisionally titled Circles of Light. Circles of Light has arisen directly from my experience of conducting this research. The work combines mechanical engineering with computer animation that has been synchronised with live action, and once again deploys the chromakey techniques outlined above. It was shot in the studio in August 1994, although the computer animation that is to be combined through the blue background will matted in post-production.

The playful posturing of the women that had serendipitously concluded To Be Born Through Our Own Hands, as outlined above, had sparked in me an awareness of the power of subtle gesture and expression, and I was able to build on this insight in formulating sequences for both the dancers and boxers in Circles of Light. The piece is also intended to carry references to To Be Born Through Our Own Hands in featuring a strong muscular woman who takes on a man in a fight of equals. For this sequence I used documentaries on Mike Tyson and fictionalised accounts of boxing like Raging Bull and some of the Rocky films to familiarise myself with different boxing terminology and moves.

In Circles of Light a man and woman engage in a Flamenco-esque dance of seduction set against background images of skin and hair, teeth and nails texture-

mapped onto computer models. The other man and woman are boxers, fighting in a virtual arena made up of the cyborg's imaginary internal organs, they exemplify the boxer as a fighting machine. Installation works like Circles of Light are notoriously difficult to curate and tour, but some curators like Helen Sloan of Camerawork Gallery in East London, Steve Bode of the London-based Film and Video Umbrella and Eddie Berg from MOVIOLA in Liverpool are dedicated to finding ways of supporting this kind of work.

In some respects these sequences are part of a continuing interest in dualisms: the inside/outside, human/machine, male/female, real/artificial. But my interest in dichotomous pairs is not so much in their common form of exclusive disjunction, but rather as couples with blurred boundaries which transgress the categories of normative dualism. The Imaginary Internal Organs of a Cyborg is one part of this project which illustrates my interest in the transgression of the normative boundary, in this case of the inside/outside and human/machine dualisms. Given the prevalence of the image of the cyborg in this thesis, it should come as no surprise that it is centrally featured in Circles of Light, where I have used a computer to image the cyborg's inner spaces, an amalgam of electromechanics and surgery. The virtual guts were modelled on a Macintosh computer using a number of modelling packages. Images similar to kidneys, intestines, and blood vessels were textured with images based on scanned photographs; and representations of meat, offal, chromium objects and microchips were then all montaged in a paint package and retouched before being texture-mapped onto the 3D computer models. I see this work as considerably less radical than that of the French performance artist Orlan who is currently appropriating plastic surgery techniques to literally "sculpt" her actual physical body. Unnervingly, the shamanic performance artist Stellarc has been taking this agenda to the very edge

of ideologically acceptable artistic practice by stringing up his hollowed out human body on hooks and wires, like a Guyanese Indian at an “I feel no pain” festival. He also persuaded Peter Sellers-like doctors to augment his body with a life size cybernetic arm, and is said to be planning an oxygen-permeable bodysuit to replace his need for lungs.

I have also become interested in developing digital video techniques which do not simply imitate cinematic devices like the fade, that conventional metaphor for “ending” which has been uncritically adopted in computer animation. This has led me to consider whether features of algorithms might replace the characteristics of the camera. I am committed to exploring further digital structures and trying to give them a metaphoric role in animation and interactive environments. This entails considering the characteristics of algorithms used in, for example, computer-simulated dissolves. One possible technical solution is to use a computer virus to provide a different visual event linking the two images. This is one of the subjects of a project I have just begun to direct in collaboration with the programmer Gordon Selley and the computer animator Andrew Kind called Technosphere. Technosphere is a computer modelled world made up of different fractal terrains (desert, mountains and forest) each shown on screen in three stages of rendering. The animation was designed to portray a world which is heralded by digital whirlwinds which spin across the screen leaving a rendering trail in their wake.

Andrew Kind is particularly interested in producing 3D “creatures”, some insect-like, others more abstract, for example appearing as a bank of colour. Gordon Selley’s interest in modelling natural phenomena is evident in the fractal terrain and complex-looking foliage of the landscape, but this interest has extended to a

determination to build dynamism into the life-forms which would enable them to evolve over time. These life-forms would be digital parallels to genetically engineered actual life-forms, but rather than being designed to conform to a close mimesis of natural life, the driving force of these algorithms might be to “migrate” through the terrain towards a colour. Unlike William Latham’s projects, the designers would not control the “breeding” or “evolution”.

One important decision was to design Technosphere as a virtual environment, perhaps one that could run somehow as an interactive world accessible over the Internet so that users could send datafiles of their creatures over the Internet to be incorporated into Technosphere and then call in at a later date for an update or 2D snapshot of their algorithm’s status. This is our current aim, though the enormous amount of work needed to get the project from the design stage to being a working piece is currently outside our reach. However the concept has generated a lot of interest and test images from a prototype Technosphere are featured in the recent issue of Ten:8 Photo-paperback which has been distributed on the Internet at cyan.media@wmin.ac.uk alongside an article “Cyberfeminizations” by Sadie Plant from Birmingham University.

BIBLIOGRAPHY

- Aaronson, Bernard and Osmond, Humphry (1971). Psychedelics: the Uses and Implications of Hallucinogenic Drugs. London: The Hogarth Press.
- Adelman, C (1980). On First Hearing. Uttering, Muttering, ed Adelman, C. London: Grant McIntyre.
- Apple, Michael W (1986). Teachers and Texts: a Political Economy of Class and Gender Relations in Education. London: Routledge and Kegan Paul.
- Argyris, Chris and Schon, Donald A (1974). Theory in Practice. San Francisco: Jossey-Bass.
- Argyris, Chris and Schon, Donald A (1991). PAR and Action Science Compared: a Commentary. Participatory Action Research, ed Whyte, William Foote. London: Sage Focus, pp85-96.
- Ascott, Roy (1992). No Simple Matter: artist as media producer in a universe of complex systems. Paper accompanying talk at Sheffield Media Show, March 1992.
- Ast, Friedrich (1990). Hermeneutics. In The Hermeneutic Tradition: from Ast to Ricoeur, eds Gayle L Ormiston & Alan D Schrift. New York: State University of New York, pp39-56.
- Athanasiou, Tom (1989). Artificial intelligence, Wishful Thinking and War. In Cyborg Worlds: the military information society. London: Free Association books, pp113-134.-
- Atkinson, George (1994). Chess and Machine Intelligence. NJ: Ablex Publishing Corporation.
- Baker, Martin (1987). Mass Media Studies and the Question of Ideology. Radical Philosophy No 46 Summer 1987. London: Central Books, pp27-33.
- Ball, Stephen J (1984) ed. Comprehensive Schooling: A Reader. London: Falmer Press.
- Barthes, Roland (1972). Mythologies. London: Jonathan Cape.
- Barthes, Roland (1981). Camera Lucida. USA: Hill and Wang.
- Barthes, Roland (1982). Barthes: Selected Writings. London: Fontana.
- Battersby, Christine (1989). Gender and Genius: Towards a Feminist Aesthetics. London: The Women's Press.
- Baudrillard, J (1983). Simulations. New York: Semiotext(e).
- Baxandall, Michael (1972). Painting and Experience in Fifteenth Century Italy. Oxford: Clarendon.
- Beardsley, Monroe C (1966). Aesthetics from Classical Greece to the Present: A Short History. New York: Macmillan.

Bell, Colin (1969). A Note on Participant Observation. Sociology Vol 3 No 3 Sept 1969, pp416-417.

Bellour, Raymond (1978). Les Livres des Autres, entretiens avec M. Foucault. Paris: Union Generale d'editions.

Benhabib, Seyla (1990). Epistemologies of Postmodernism: A Rejoinder to Jean-Francois Lyotard. Feminism/Postmodernism, ed Nicholson, Linda J. London: Routledge, pp107-132.

Benjamin, Walter (1970). Art in the Age of Mechanical Reproduction. Illuminations, 1970, pp385-408.

Benyon, Margeret (1988). Holography: an artists view. The Photographic Journal, November 1988, pp494-497.

Benyon, Margeret (1991). Women's Art, No. 42, September/October 1991. London: The Women's Artists Slide Library Archive.

Benyon, Margeret (1982). On the Second Decade of Holography as Art and my Recent Holograms. Leonardo, Vol.15, No.2. London: Pergamon Press, pp89-95.

Berger, Peter and Luckmann, Thomas (1967). The Social Construction of Reality. London: Penguin.

Berger, John (1972). Ways of Seeing. London: Writers and Readers.

Birren, Faber (1969). Principles of Colour. New York: Von Nostrand Rheinhold Co.

Blinn, J (1982). Light Reflection Functions for Simulations and Dusty Surfaces. ACM Computer Graphics, Vol 16, No3, July 1982, pp21-29.

Bordo, Susan (1990). Feminism, Postmodernism, and Gender-Scepticism. Feminism/Postmodernism, ed Nicholson, Linda J. London: Routledge, pp133-156.

Bunch, John B (1986). Educational Media and Aesthetic Education 1986 Journal of Aesthetic Education, Vol. 20, No. 3, Fall 1986, pp81-92.

Burgess, R G (1984). In the Field: An Introduction to Field Research. London: George Allen and Unwin.

Burke, Edmund (1958). A Philosophical Enquiry into the Origin of our Ideas of the Sublime and Beautiful, ed Boulton, J T. London: Routledge and Kegan Paul.

Bush, Vannevar (1945). As We May Think. Atlantic Monthly, 176 (July 1945), pp101-108.

Butler, Susan (1986). So How Do I Look? Women Before and Behind the Camera. Staging the Self. London: National Portrait Gallery.

Buzan, Tony (1974). Use Your Head. London: BBC.

- Campbell, D T and Stanley J C (1963). Experimental and Quasi-Experimental Designs for Research on Teaching. Handbook on Research on Teaching, ed Gage, N L. Chicago: Rand MacNally.
- Capra, Fritjof (1975). The Tao of Physics. London: Flamingo.
- Capra, Fritjof (1983). The Turning Point. London: Wildwood House.
- Carr, Wilfred and Kemmis, Stephen (1986) Becoming Critical: Education, Knowledge and Action Research. London: Falmer.
- Cebik, L, B (1990). Knowledge or Control as the End of Art. British Journal of Aesthetics, Vol. 30, No. 3, July 1990.
- Chambers Science and Technology Dictionary (1991). ed Peter M B Walker. Edinburgh: W & R Chambers.
- Chevreul, M E (1981). The Principles of Harmony and Contrast of Colours and their Application to the Arts. New York: Van Nostrand Rheinhold.
- Chodorow, Nancy (1978). The Reproduction of Mothering: Psychoanalysis and the Sociology of Gender. Berkeley: University of California Press.
- Collins, Susan (1988). Redressing the Myth. Independent Media, March/April 1988, pp10-11.
- Corbeil, Pierre (1988). History and Electronic Technology: New Tools for New Questions. Simulation/Games for Learning, Vol 18, No 2, June 1988, pp127-135.
- Creed, Barbara (1990). Alien and the Monstrous Feminine. Alien Zone: Cultural Theory and Contemporary Science Fiction Cinema, ed Kuhn, Annette. London: Verso.
- Cullingford, Cedric (1984). Children and TV. Aldershot: Gower Press.
- Curti, Lidia (1992). What is Real and What is Not?: Female Fabulations in Cultural Analysis. Cultural Studies, eds Grossberg, Lawrence, Nelson, Cary and Treichler, Paula. London: Routledge, pp134-153.
- Darwin, Charles (1871). The Descent of Man, and Selection in Relation to Sex. New York: Random House Inc.
- Davis, Lynn (1984). Gender and Comprehensive Schooling. Comprehensive Schooling: a Reader, ed Stephen J Ball. London: The Falmer Press, pp47-66.
- Deleuze, Gilles and Guattari, Felix (1983). On the Line. New York: Semiotext(e).
- Deleuze, Gilles and Guattari, Felix (1986). Nomadology: the War Machine. New York: Semiotext(e).
- Dilthey, Wilhelm (1990). The Rise of Hermeneutics, The Hermeneutic Tradition: from Ast to Ricoeur, eds Gayle L Ormiston & Alan D Schrift. New York: State University of New York, pp101-114.

- Dreyfous, Hubert L and Rabinow, Paul (1982). Michel Foucault: Beyond Structuralism and Hermeneutics. UK: Harvester Wheatsheaf.
- Druckrey, Timothy (1993). Feedback to Immersion: Machine Culture to Neuromachines/Modernity to Post Modernity. SIGGRAPH Computer Graphics Visual Proceedings. New York: ACM SIGGRAPH, pp126-128.
- Dworkin, Andrea (1981). Pornography: Men Possessing Women. London: Women's Press.
- Eagleton, Terry (1983). Literary Theory: An Introduction. Oxford: Basil Blackwell.
- Eilenberger, G (1986). Freedom, Science and Aesthetics. The Beauty of Fractals, eds H -O Peitgen and P H Richter. Berlin: Springer-Verlag, pp175-180.
- Elden, Max and Levin, Morten (1991). Cogenerative Learning: Bringing Participation into Action Research. Participatory Action Research, ed Whyte, William Foote. London: Sage Focus, pp127-142.
- Elliott, John (1987). Educational Theory, Practical Philosophy and Action Research. British Journal of Educational Studies, 25, 2. Milton Keynes: Open University Press.
- Elliott, John (1987). Teachers as Researchers. International Encyclopedia of Teaching and Teacher Education, ed Dunkin, Michael J . Oxford: Pergamon Press, pp162-164. -
- Elliott, John (1991). Action Research for Educational Change. Milton Keynes: Open University Press.
- Elliott, John and Whitehead, D (1980). CARN Bulletin No 4. Cambridge: Cambridge Institute of Education.
- Elliott, John and Whitehead, D (1982). CARN Bulletin No 5. Cambridge: Cambridge Institute of Education.
- Escher, M C (1992). The Graphic Work: Introduced and Explained by the Artist. Translated by John E Brigham. Holland: Benedikt Taschen.
- Faraday, Annabel (1989). Lessoning Lesbians: Girls' Schools, Coeducation and Anti-lesbianism Between the Wars. Learning our Lines, eds Jones, Carol and Mahony, Pat. London: The Women's press, pp23-45.
- Faulkner, Wendy and Arnold, Erik (1985) eds. Smothered by Invention: Technology and Women's Lives. London: Pluto.
- Feller, Robert L (1986) ed. Artists Pigments: a Handbook of their History and Characteristics. London: Cambridge University Press.
- Ferguson, Ann (1992). A Feminist Aspect Theory of Self. Women, Knowledge and Reality: Explorations in Feminist Philosophy, eds Garry, Ann and Pearsall, Marilyn. London: Routledge, pp93-108.

- Figes, Eva (1986). Patriarchal Attitudes. London: Macmillan.
- Firestone, Shulamith (1970). The Dialectic of Sex. New York: Bantam.
- Fiumara, Gemma Corradi (1994). The Metaphoric Function and the Question of Objectivity. Knowing the Difference: Feminist Perspectives in Epistemology. eds Lennon, Kathleen and Whitford, Margaret. London: Routledge, pp31-44.
- Foucault, Michel (1981). Power/Knowledge. ed Gordon, Colin. New York: Random House.
- Franke, H W (1986). Refractions of Science into Art. The Beauty of Fractals. eds Peitgen, H -O and Richter, P H. Berlin: Springer-Verlag, pp181-188.
- Fraser, Nancy and Nicholson, Linda J (1990). Social Criticism without Philosophy: An Encounter between Feminism and Postmodernism. Feminism/Postmodernism, ed Nicholson, Linda J. London: Routledge, pp19-38.
- Freeman, John Craig (1991). Operation Green Run 11. Ten 8 Photopaperback, Vol 2 No2 Autumn 1991. London: Ten 8, pp32-33.
- Frisby, John P (1979). Seeing: Illusion, Brain and Mind. UK: Oxford University Press.
- Fullan, M (1982) . The Meaning of Educational Change. New York: Teachers College Press.
- Gadamer, Hans-Georg. Truth and Method ("Introduction" and "Foreward" to the Second Edition. In The Hermeneutic Tradition: from Ast to Ricoeur, eds Gayle L Ormiston & Alan D Schrift. New York: State University of New York.
- Garry, Ann and Pearsall, Marilyn (1992). Women, Knowledge and Reality: Explorations in Feminist Philosophy. London: Routledge.
- Gearhart, Sally Miller (1983). Female Futures in Women's Science Fiction. The Technological Woman: Interfacing with Tomorrow, ed Zimmerman, Jan. New York: Praeger, pp 245-251.
- Geertz, Clifford (1973). The Interpretation of Cultures. New York: Basic Books.
- Geertz, Clifford (1983). Local Knowledge. New York: Basic Books.
- Gibson, William (1984). Neuromancer. London: Grafton.
- Gilligan, Carol (1982). In a Different Voice: Psychological Theory and Women's Development. Cambridge, Mass: Harvard University Press.
- Gillman, Clive (1990) . Two Days in a Northern Chip Shop. Independent Media, January 1990, Issue 88. London: Central Books, p22.
- Giroux, Henry (1992). Resisting Difference: Cultural Studies and the Discourse of Critical Pedagogy. Cultural Studies, eds Grossberg, Lawrence, Nelson, Cary and Treichler, Paula. London: Routledge, pp199-212.

- Glaser, Barney G and Strauss, Anselm L (1967). The Discovery of Grounded Theory. Chicago: Aldine.
- Gleick, James (1987). Chaos: Making a New Science. England: Penguin.
- Goffman, Erving (1968). Asylums: Essays on the Social Situation of Mental Patients and Other Inmates. London: Penguin.
- Goffman, Erving (1969). The Presentation of Self in Everyday Life. London: Mayflower.
- Goodman, Cynthia (1987). Digital Visions: Computers and Art. New York: Harry N Abrams Inc.
- Gould-Davis, Elizabeth (1971). The First Sex. London: J.M. Dent and Sons.
- Gramsci, Antonio (1975). Selections from the Prison Notebooks of Antonio Gramsci, eds Hoare, Quintin and Nowell Smith, Geoffrey. London: Lawrence and Wishart.
- Gray, Chris Hables (1989). The Cyborg Soldier: The US military and the Post-Modern Warrior. Cyborg Worlds: the military information society, eds Les Levidow and Kevin Robins. London: Free Association books, pp43-71.
- Grinspoon, Lester and Bakalar, James B (1979). Psychedelic Drugs Reconsidered. New York: Basic Books.
- Grundy, S and Kemmis, S (1981). Educational Action Research in Australia: the State of the Art. Australia: Deakin University Press.
- Haber, John (1988). Seeing the Picture for Real, The Guardian, Thursday March 17th 1988. London.
- Haraway, Donna (1985). A Manifesto for Cyborgs, Socialist Review, No 10.
- Haraway, Donna (1990). A Manifesto for Cyborgs: Technology and Socialist Feminism in the 1980s. Feminism/Postmodernism, ed Nicholson, Linda J. London: Routledge, pp190-233.
- Haraway, Donna (1992). The Promises of Monsters: a Regenerative Politics for Inappropriate/d Others. Cultural Studies, eds Grossberg, Lawrence, Nelson, Cary and Treichler, Paula. London: Routledge, pp295-337.
- Harding, Sandra (1990). Feminism, Science and Anti-Enlightenment Critiques. Feminism/Postmodernism, ed Nicholson, Linda J. London: Routledge, pp83-106.
- Harding, Sandra (1992). Feminist Justificatory Strategies. Women, Knowledge and Reality: Explorations in Feminist Philosophy, eds Garry, Ann and Pearsall, Marilyn. London: Routledge, pp189-202.
- Hardison, R D Jr (1990). Disappearing Through The Skylight: Culture and Technology in the Twentieth Century. England: Penguin.

- Hartsock, Nancy (1987). Rethinking Modernism: Minority vs. Majority Theories. Cultural Critique 7, pp187-206.
- Hartsock, Nancy (1990). Foucault on Power: A Theory for Women? Feminism/Postmodernism, ed Nicholson, Linda J. London: Routledge, pp157-176.
- Hatch, Connie (1987). Serving the Status-Quo (from the transcripts). ed Wallis, Brian, Blasted Allegories: an Anthology of Writings by Contemporary Artists. London: MIT Press, pp42-57.
- Hawking, Stephen W (1988). A Brief History of Time. London: Bantam.
- Hewison, Robert (1990). Future Tense: New Art for the Nineties. London: Methuen.
- Hirst, Paul H (1965). Education and the Development of Reason. London: Routledge and Kegan Paul.
- Homer, William Innes (1985). Seurat and the Science of Painting. London: Hacker Art Books.
- Hooper, R (1977). The NDPCAL: Final Report of the Director. London: CET Publications.
- Howard, Graham (1988). Towards a Critique. Computer Images International, August 1988, pp39.
- Hoyle, Eric (1970). Curriculum Change. E283 The Curriculum, Context, Design and Development. London: Open University Press.
- Hudson, Tom (1987). Current Issues in Art and Design Education: Art, Science and Technology; Some Initiatives for Change. Journal of Art and Design Education, Vol 6, No 3, 1987, pp261-283.
- Hughes, Mary and Kennedy, Mary (1985). Dilemmas of Innovation. New Futures - Changing Women's Education. London: Routledge and Kegan Paul, pp161-17.
- Hussey, Christopher (1967). The Picturesque: Studies in Point of View. London: Cass.
- Hutchings, Kimberly (1994). The Personal is International: Feminist Epistemology and the Case of International Relations. Knowing the Difference: Feminist Perspectives in Epistemology, ed Lennon, Kathleen and Whitford, Margaret. London: Routledge, pp149-163.
- Imhoff, Barbara and Milhon, Jude (1991). Ellen Sebastian: the Loa in the Machine. Mondo 2000, Issue No.4, California: Fun City Megamedia, pp78-83.
- Irigaray, Luce (1985). The Sex Which Is Not One, translated by Catherine Porter. Ithaca: Cornell University Press.
- Jaeger, Richard M (1988). Complementary Methods For Research in Education. Washington: AERA.

- Jaggar, Alison M (1992). Love and Knowledge: Emotion in Feminist Epistemology. Women, Knowledge and Reality: Explorations in Feminist Philosophy, eds Garry, Ann and Pearsall, Marilyn. London: Routledge, pp129-156.
- James, Charity (1968). Young Lives at Stake. London: Collins.
- Jenkins, DR, Batts, D, and Davis, R (1985). Initiative: Take One. An Interim Report on Coventry TVEI. Warwick: University of Warwick.
- Jenkins, David (1992). Curriculum Research. The International Encyclopedia of Curriculum, ed Lewy, Arie. New York: Pergamon Press, pp46-41.
- Jenkins, David (1993). Exhuming the Undertaker: the Quest for the Hidden Curriculum. Paper given as part of the series Towards the Twenty-First Century., University of the South Pacific: Limited Circulation.
- Kemmis, Stephen (1976). The Contributions of Nomothetic and Idiographic Approaches to the Evaluation of Student Learning in the National Development Programme. Paper produced for the SSRC/Research Seminar on Computers in Education held at Warwick University.
- Kemmis, Stephen (1978). Nomothetic and Idiographic Approaches to the Evaluation of Learning. Curriculum Studies 1978 Vol 10 No 1, pp45-59.
- Kent, Sarah (1980). Pretty Promises, Happy Traps. Time Out, 1980, No 550, p23.
- Kince, Eli (1982). Visual Puns in Design. New York: Watson-Guptill, p137.
- Kinneavy, James L (1983). The Relation of the Whole to the Part in Interpretation Theory and in the Composing Process. Visible Language Volume xvii, Number 2, Spring 1983. Ohio: Visible Language.
- Kipnis, Laura (1992). (Male) Desire and (Female) Disgust: Reading Hustler. Cultural Studies, eds Grossberg, Lawrence, Nelson, Cary and Treichler, Paula. London: Routledge, pp373-391.
- Kluver, Heinrich (1966). Mescal and Mechanisms of Hallucinations. Chicago: University Chicago Press.
- Krueger, Myron (1990). Artificial Realities 11. USA: Addison-Wesley.
- Kuhn, Thomas (1962). The Structure of Scientific Revolutions, 2nd Edition. Chicago: University of Chicago Press.
- Landow, George P (1989). Hypertext in Literary Education, Criticism and Scholarship. Computers and the Humanities, 23. Netherlands: Kluwer, pp173-198.
- Laura, Dr Ronald and Ashton, John (1991). The VDU connection: Could it be Terminal!! The Vitamin Connection July/August 1991, pp40-42.
- Lauretis, Teresa de (1993). Upping the Anti [sic] in Feminist Theory. The Cultural Studies Reader, ed Simon During. London: Routledge, pp74-89.

- Lawton, Dennis (1980). The Politics of the School Curriculum. London: Routledge.
- Lazreg, Marnier (1994). Women's Experience and Feminist Epistemology: A Critical Neo-Rationalist Approach. Knowing the Difference: Feminist Perspectives in Epistemology, ed Lennon, Kathleen and Whitford, Margaret. London: Routledge, pp45-62.
- Lewy, A (1992) ed. International Encyclopedia of the Curriculum. New York: Pergamon Press.
- Linn, Pam (1987). Gender Stereotypes, Technology Stereotypes. Gender and Expertise, ed McNiel, Maureen. London: Free Association books, pp127-151.
- Lloyd, Anne and Newell, Liz (1985). Women and Computers in eds Faulkner, Wendy and Arnold, Erik (1985). Smothered by Invention: Technology and Women's Lives. London: Pluto, pp238-251.
- Lloyd, Genevieve (1984). The Man of Reason: "Male" and "Female" in Western Culture. Minneapolis: University of Minnesota Press.
- Lloyd, Genevieve (1992). The Man of Reason. Women, Knowledge and Reality: Explorations in Feminist Philosophy, eds Garry, Ann and Pearsall, Marilyn. London: Routledge, pp111-128.
- Lyotard, Jean-Francois (1984). The Post-Modern Condition: A Report on Knowledge. Minneapolis: University of Minnesota Press.
- MacDonald Ross, Michael (1972). The Problem of Representing Knowledge. UK: Open University.
- MacDonald Ross, Michael (1974). Glass Beads and Geometric Monsters: the Problems of Representing Knowledge. UK: Open University.
- MacKinnon, Catherine (1983). Feminism, Marxism, Method and the State: Toward Feminist Jurisprudence. Signs, 8.4
- Mahony, Pat (1989). Sexual Violence and Mixed schools. Learning our Lines, eds. Carol Jones and Pat Mahony 1989. London: The Women's press, pp157-190.
- Mailer, Norman (1973). Marilyn: A Biography. New York: Pegriree Books.
- Mandelbrot, Benoit (1982). Fractal Geometry of Nature. New York: WH Freeman and Co.
- Marder, David (1984). Evening Echo. Wednesday October 3rd, Bournemouth.
- Marshall, Stuart (1990). Video Installation in Britain: the Early Years. Signs of the Times: a decade of video, film and slide-tape installation in Britain 1980-1990. Oxford: Museum of Modern Art, pp12-17.
- Martin, Emily (1992). Body Narratives, Body Boundaries. Cultural Studies, eds Grossberg, Lawrence, Nelson, Cary and Treichler, Paula. London: Routledge, pp409-418.

- Marwick, Arthur (1989). The Nature of History, 3rd Edition. Basingstoke: MacMillan.
- Maziere, Michael (1991) ed. London Video Access Catalogue. London: Arts Council.
- McCaffrey, Larry (1991) An interview with Kathy Acker. Mondo 2000, Issue No 4. California: Fun City Megamedia, pp72-77.
- McCorduck, P (1979). Machines Who Think. San Francisco, CA: W H Freeman.
- McGuinness, Brian (1988). Wittgenstein: A Life. Young Ludwig 1889-1921. London: Duckworth.
- McLuhan, Marshall (1962). The Gutenberg Galaxy. New York: McGraw-Hill.
- McWinnie, Harold J (1989). The Use of Computers in the Arts: Simulation versus Abstraction. Leonardo, Vol 22, No 2. London: Pergamon Press, pp167-170.
- Mead, George Herbert (1934). Works of George Herbert Mead: Volume 1, Mind Self and Society from the Standpoint of a Social Behaviorist. ed Morris, Charles W. Chicago: University of Chicago Press.
- Mills, Sara; Pearce, Lynne; Spaul, Sue and Millard, Elaine (1989). Feminist Readings: Feminist Reading. UK: Harvester Wheatsheaf.
- Morris, Judith (1989). Women in Computing. Great Britain: Computer Weekly Publications.
- Moulton, Janice (1992). A Paradigm of Philosophy: The Adversary Method. Women, Knowledge and Reality: Explorations in Feminist Philosophy, eds Garry, Ann and Pearsall, Marilyn. London: Routledge, pp5-20.
- Nadin, Mihai (1989). Emergent Aesthetics-Aesthetic Issues in Computer Arts. Leonardo Computer Art in a Context, Supplemental Issue. London: Pergamon Press, pp43-48.
- Nancy, Jean-Luc (1990) cited In The Hermeneutic Tradition: from Ast to Ricoeur, eds Gayle L Ormiston & Alan D Schrift. New York: State University of New York.
- Nelson, Ted (1987). Literary Machines. USA: published by the author.
- Nicholson, Linda J (1990) ed. Feminism/Postmodernism. London: Routledge.
- Noble, Douglas D (1989). 'Mental Materiel: The militarisation of learning and intelligence in US education.' Cyborg Worlds: the military information society. eds Les Levidow and Kevin Robins. London: Free Association books, pp13-42.
- Nye, Andrea (1992). The Voice of the Serpent: French Feminism and Philosophy. Women, Knowledge and Reality: Explorations in Feminist Philosophy, eds Garry, Ann and Pearsall, Marilyn. London: Routledge, pp233-250.

Olson, Paul (1985). Who Computes? The politics of Literacy. Unpublished paper. Ontario Institute for Studies in Education, Toronto.

Ong, Walter J (1982). Orality and Literacy: The Technologising of the Word. London: Methuen.

Ormiston, Gayle L and Schrift, Alan D (1990). The Hermeneutic Tradition: from Ast to Ricoeur. New York: State University of New York Press.

Owen, William (1988). The New Michelangelos? Computer Images International, October 1988, pp14-16.

Palmer, Richard E (1969). Hermeneutics: Interpretation Theory in Schleiermacher, Dilthey, Heidegger, and Gadamer. Evanston: Northwestern University Press.

Parker, Roszika and Pollock, Griselda (1987) eds. Framing Feminism: Art and the Women's Movement 1970-1985. London: Pandora.

Parker, Roszika (1990). Images of Men. Women's Images of Men, ed. Kent, Sarah and Morreau, Jacqueline. London: Pandora.

Parlett, M and Hamilton, D (1972). Evaluation as Illumination. Beyond the Numbers Game, (1977) ed Hamilton, D. London: MacMillan.

Pask, Gordon (1972). Curriculum Context. Design and Development. Teaching Strategies - a Systems Approach. Bletchley: Open University Press.

Peake, Catherine (1980). LIP Feminist magazine. Australia 1980, pp94-95.

Peitgen, H -O and Richter, P H (1986) eds. The Beauty of Fractals. Berlin: Springer-Verlag.

Penrose, Roger (1989). The Emperor's New Mind: Concerning Computers, Minds, and The Laws of Physics. Oxford: Oxford University Press.

Phong, B T (1975). Illumination for computer generated images. Communications of the ACM, June 1975 18(6), pp311-317

Pickover, Clifford A (1990). Computers, Pattern, Chaos and Beauty: Graphics from an Unseen World. UK: Alan Sutton.

Plato (1938). Portrait of Socrates: being the "Apology", "Crito" and "Phaedo". An English translation with introduction and notes by Sir R W Livingstone. London: Oxford University Press.

Plowman, Lydia (1988). Interactive Video, Independent Media, October 1988, Issue 82. London: Central Books, pp12-13.

Popper, Sir Karl (1958). The Logic of Scientific Discovery. New York: Harper and Row.

- Probyn, Elspeth (1990). Travels in the Postmodern: Making Sense of the Local. Feminism/Postmodernism, ed Nicholson, Linda J. London: Routledge, pp176-189.
- Prophet, Jane (1989). Sequitur. Unpublished MA thesis. Coventry University: Department of Graphic Design.
- Redfern, Angela and Edwards, Viv (1986). World in a Classroom: Language in Education in Britain and Canada. London: Fulton.
- Reichardt, Jasia (1968) ed. Cybernetic Serendipity: the Computer and the Arts. London: Studio International.
- Rheingold, Howard (1991). Virtual Reality. Great Britain: Secker and Warburg.
- Ricoeur, Paul (1991). From Text to Action: Essays in Hermeneutics, 11. USA: Northwestern University Press, Evanston, Illinois.
- Robinson, Ken et al (1982). Arts in Schools: Principles, Practice and Provision, a report by the Calouste Gulbenkian Foundation. London: Oyez Press.
- Rorty, Amelie O (1980) ed. Explaining Emotions. Berkeley: University of California Press.
- Rorty, Richard (1979). Philosophy and the Mirror of Nature. Princeton: Princeton University Press.
- Rosaldo, Michelle Zimbalist (1974). Woman, Culture, and Society: A Theoretical Overview. Woman, Culture, and Society, eds Rosaldo, Michelle Zimbalist and Lamphere, Louise. Stanford: Stanford University Press, pp17-42.
- Rose, Hilary (1983). Hand, Brain and Heart: A Feminist Epistemology for the Natural Sciences. Signs: Journal of Women in Culture and Society 9 (1). pp73-90.
- Ross, Andrew (1992). New Age Technoculture. Cultural Studies, eds Grossberg, Lawrence, Nelson, Cary and Treichler, Paula. London: Routledge, pp531-547.
- Ross, Andrew (1993). The Popularity of Pornography. The Cultural Studies Reader, ed Simon During. London: Routledge, pp221-241.
- Ross, M (1975). Art and the Adolescent. Schools Council Working Paper 54. London: Evans Methuen.
- Rothschild, Joan (1988). Teaching Technology from a Feminist Perspective. New York: Pergamon Press.
- Rothschild, Joan (1983). Machina Ex Dea: Feminist Perspectives on Technology. New York: Pergamon Press.
- Rubin, Gaye (1975). The Traffic in Women. Toward an Anthropology of Women, ed Reiter, Raynar R. New York: Monthly Review Press, p160.
- Rudduck, Jean (1983). The Humanities Curriculum Project: An Introduction. Revised by Jean Rudduck. Great Britain: University of East Anglia.

- Russell, David (1970). Arts Magazine, February. London.
- Russell, Dora (1983). The Religion of the Machine Age. London: Routledge and Kegan Paul.
- Saint-Marie, Buffy (interviewed on TV AM, Thames Television on Thursday January 30th 1992).
- Sanford, Nevitt (1981). A Model for Action Research. Human Inquiry, eds Reason, P and Rowan, J. New York: John Wiley and Sons Ltd, pp173-181.
- Saunders, Lesley (1987) ed. Glancing Fires: an investigation into women's creativity. London: The Women's Press.
- Scheman, Naomi (1993). Engenderings: Constructions of Knowledge, Authority and Privilege. London: Routledge.
- Schwab, J J (1971). The Practical: a Language for Curriculum. Science, Curriculum and Liberal Education. Chicago: University of Chicago Press.
- Scriven, Michael (1988). Philosophical Inquiry Methods in Education. Complementary Methods For Research in Education, ed Jaeger, Richard M. Washington: AERA, pp131-154.
- Searle, John R (1987). Minds and Brains without Programs, Mindwaves, ed C Blakemore and S Greenfield. Oxford: Basil Blackwell, pp211-260.
- Selley, Gordon (1991). TWIGS: Trees and Woods Image Generation System. Unpublished PhD thesis. Coventry University.
- Shaftesbury, Anthony Ashley 3rd Earl of (1900). Characteristics of Men, Manners, Opinions, Times Etc., ed Robertson, J M. London.
- Sherwin, Susan (1992). Philosophical Methodology and Feminist Methodology: Are They Compatible? Women, Knowledge and Reality: Explorations in Feminist Philosophy, eds Garry, Ann and Pearsall, Marilyn. London: Routledge, pp21-36.
- Shulman, Lee S (1988). Disciplines of Inquiry in Education: An Overview. Complementary Methods For Research in Education, ed Jaeger, Richard M. Washington: AERA, pp3-23.
- Slonczewski, Joan (1987). A Door into Ocean. London: Women's Press.
- Smith, Brian Reffin (1989). Beyond Computer Art. Leonardo Computer Art in a Context, Supplemental Issue. London: Pergamon Press 1989, pp39-41.
- Smith, Dorothy (1974). Women's Perspective as a Radical Critique of Sociological Sociological Inquiry 44, pp7-13.
- Smith, Judy (1983). Women and Appropriate Technology: A Feminist Assessment. The Technological Woman: Interfacing with Tomorrow, ed Zimmerman, Jan. New York: Praeger, pp65-75.

- Smith-Rosenberg (1985). Disorderly Conduct. Oxford: Oxford University Press.
- Snitnow A, Stansell C and Thompson S (1984). Desire: the Politics of Sexuality. London: Virago.
- Solomon, Robert (1976). The Passions. New York: Doubleday.
- Sontag, Susan (1977). On Photography. New York: Delta.
- Sontag, Susan (1982). A Susan Sontag Reader. London: Penguin.
- Spelman, Elizabeth V (1992). Anger and Insubordination. Women, Knowledge and Reality: Explorations in Feminist Philosophy, eds Garry, Ann and Pearsall, Marilyn. London: Routledge, pp263-274.
- Spence, Jo (1986). Putting Myself in the Picture: A Political, Personal and Photographic Autobiography. London: Camden Press.
- Spencer, Jane (1986). The Rise of the Woman Novelist: from Aphra Behn to Jane Austen. London: Basil Blackwell.
- Spender, Dale (1985). Man Made Language. London: Routledge and Kegan Paul.
- Stake, R (1977). Portrayal Evaluation. Paper given at CARE, University of Essex Anglia (limited circulation).
- Stake, Robert E (1988). Case Study Methods in Educational Research: Seeking Sweet Water. Complementary Methods For Research in Education, ed Jaeger, Richard M. Washington: AERA, pp253-265.
- Stam, Robert (1988). Bakhtin and Left Cultural Critique. Postmodernism and its Discontents: Theories, Practices, ed Kaplan, E Ann. London: Verso.
- Stanworth, Michelle (1987). Girls on the Margins: a Study of Gender Divisions in the Classroom. Gender Under Scrutiny: New Inquiries in Education, eds Weiner, Gaby and Arnot, Madeleine. London: Unwin Hyman, pp198-212.
- Steiner, Rudolf (1970). Colour. London: Rudolf Steiner Press.
- Stenhouse, Lawrence (1970). The Humanities Project: an Introduction. London: Heinemann.
- Stenhouse, Lawrence (1975). An Introduction to Curriculum Research and Development. Curriculum Research and Development in Action, ed Stenhouse, Lawrence. London: Heinemann.
- Stiller, Louis (1990). The Original Cyber Punk. Electric Word Vol 20 1990, pp34-36.
- Sussman, Vic (1986). Personal Technology Lends a Hand. Washington Post.
- Sutherland, Ivan (1962). Sketchpad. Massachusetts: MIT.

- Tawney, David (1969). Project Technology. University of Keele: Limited circulation.
- Thomas, Susan (1989). Mind and Machine, Women and Computing Newsletter, Number 29, September 1989, pp19-20.
- Tickner, Lisa (1987). The Body Politic: Female Sexuality and Women Artists since 1970. Framing Feminism: Art and the Women's Movement 1970-1985, eds Parker, Roszika and Pollock, Griselda. London: Pandora, pp263-276.
- Tolmach Lakoff, Robin (1983). Double Talk: Sexism in Tech Talk. The Technological Woman: Interfacing with Tomorrow, ed Zimmerman, Jan. New York: Praeger, pp38-44.
- Trueman, Myfawny (1988). CAD for Art and Design. Computer Aided design in FE, ed Ingham, Dr Peter. FE Unit, 1988, pp41-47.
- Turkle, Sherry (1984). The Second Self: Computers and the Human Spirit. London: Granada.
- Turing, A (1950). Computing Machinery and Intelligence. MIND magazine, USA.
- Tyler, R W (1949). Basic Principles of Curriculum and Instruction. Chicago: University of Chicago Press.
- Untersteiner, Mario (1954). The Sophists, translated by Kathleen Freeman. Oxford: Basil Blackwell.
- Van Noort, Sue (1989). Watching is Active Too. The Media Education Journal, Number 8, pp6-7.
- Verostko, Roman (1990). Epigenetic Painting: Software as Genotype. Leonardo Vol 23 No 1. London: Pergamon Press, pp17-23.
- Vogel, Sandra (1991). Gender Stereotyping and Leisure Software. Women in Computing Newsletter, 32, June 1991, pp20-23.
- Wajcman, Judy (1991). Feminism Confronts Technology. London: Polity.
- Walker, Rob (1985). Doing Research: a Handbook for Teachers. London: Methuen.
- Wallis, Brian (1987) ed. Blasted Allegories: An Anthology of Writings by Contemporary Artists. New York: MIT Press.
- Walters J, Hodges M, Simmons S. Sampling the Image: Computers in Arts Education. Journal of Aesthetic Education Vol 22, No 1, Spring 1988, pp99-110.
- Walton, Ann (1987). Exams for the Boys. The physical sciences and computing London: The Fawcett Society, pp11-15.
- Weinberg, Marty (1987). Deviance: the Interactionist Perspective, eds Rubington, Earl and Weinberg, Martin S. New York: Macmillan.

- Weininger, Otto (1903). Sex and Character. London: Heinemann.
- Whitbeck, Caroline (1992). A Different Reality: Feminist Ontology. Women, Knowledge and Reality: Explorations in Feminist Philosophy, eds Garry, Ann and Pearsall, Marilyn. London: Routledge, pp51-76.
- Whyte, William Foote (1991)ed. Participatory Action Research. London: Sage Focus.
- Whyte, William Foote (1991).Comparing PAR and Action Science. Participatory Action Research, ed Whyte, William Foote. London: Sage Focus, pp97-98.
- Whyte, William Foote, Greenwood, Davydd J and Lazes, Peter (1991). Participatory Action Research: Through Practice to Science in Social Research. Participatory Action Research, ed Whyte, William Foote. London: Sage Focus, pp19-55.
- Wilcox, Michael (1989). Blue and Yellow Don't Make Green. London: Collins.
- Willis, Paul (1977). Learning to Labour. Farnborough: Saxon House.
- Winter, D (1982). Dilemma Analysis: a Contribution to Methodology for Action Research. Cambridge Journal of Education 12 (3), pp161-174.
- Witkin, Robert (1974). The Intelligence of Feeling. London Heinemann.
- Wolcott, Harry F (1988). Ethnographic Research in Education. Complementary Methods For Research in Education, ed Richard M Jaeger. Washington: AERA, pp187-206.
- Wolf, Gary (1991) Avita Ronell: on Hallucinogens. Mondo 2000, Issue No.4. California: Fun City Megamedia, pp62-69.
- Wolff, Janet (1992). Excess and Inhibition: the Interdisciplinary in the Study of Art. Cultural Studies, eds Grossberg, Lawrence, Nelson, Cary and Treichler, Paula. London: Routledge, pp706-716.
- Woolley, Benjamin (1993). Virtual Worlds. London: Penguin.
- Wostenholm, P (1991). Interview with the artist.
- Wright, Richard (1989). The Image and 'Computer Art', Leonardo Computer Art in a Context Supplemental Issue 1989. London: Central Books, pp49-53.
- Wyver, John (1991). The Necessity of Doing Away with Video Art. London Video Access Catalogue. ed Maziere, Michael. London: Arts Council., pp45-49.
- Yeatman, Anna (1990). A Feminist Theory of Social Differentiation. Feminism/Postmodernism, ed Nicholson, Linda J. London: Routledge, pp281-299.

Yeatman, Anna (1994). Postmodern Epistemological Politics and Social Science. Knowing the Difference: Feminist Perspectives in Epistemology, ed Lennon, Kathleen and Whitford, Margaret. London: Routledge, pp187-202.

Zimmern , Alice (1988). Renaissance in Girls Education. London: Innes and Co